



Original Research Article

An Assessment of Medical Waste Management Practice in Kano Metropolis: The Case of Murtala Mohammed Specialist Hospital

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ABSTRACT

The effective management of healthcare waste is an important element towards safeguarding public health and environmental quality. However, its practice in many parts of the less developed regions of the world is poor and considerably different from what is practiced in most of more developed regions. In Nigeria, for instance, healthcare waste is often co-disposed along with other wastes. This is unsustainable and not in compliance with global best practice. To identify areas of improvement, this paper assessed systematically, the practice of healthcare waste management and compliance with global standards in Murtala Mohammed Specialist Hospital in metropolitan Kano, Nigeria. Structured questionnaires, semi-formal interviews, observations and secondary sources of data were used in the research. The data were analysed using SPSS. The findings suggest a considerable level of awareness and knowledge (50%) of hospital waste management practices among the staff. However, most (66%) of them remain untrained in medical waste management. The study also observed low levels of compliance to global standards of healthcare waste management practices in the hospital. These include documentation, waste segregation, treatment, storage and final disposal. The most common practices of final waste disposals are burning (40%) and burying (30%) followed by open dumping (15%). Challenges observed from this research range from inadequate facilities for waste storage and final disposal to staff training and lack of awareness. Accordingly, some steps were recommended towards effective and sustainable healthcare waste management in the area.

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1. INTRODUCTION

Hospitals are health institutions providing patient care services (Patil and Pokhrel, 2005). It is the duty of hospitals and healthcare centres to take care of public health. This may directly be through patient care or by

ensuring clean and healthy environment for their employees and the community. Waste can be defined as any useless or unwanted material rejected as spoiled and no longer required for its original purpose and for which there is no economic demand and hence must be discarded (Adesina and Igbuku, 1988). Hospital waste is referred to as waste, including solid and liquid waste products from healthcare establishments, research facilities and laboratories, blood banks, nursing homes, mortuaries, autopsy centres, etc. They can be hazardous (infectious, pharmaceuticals, sharps, chemical, radioactive and heavy metals) or non-hazardous (paper packaging, debris, etc).

The sustainable management of healthcare waste (HCW) has continued to generate public interest due to the health problems associated with exposure of human beings to potentially hazardous wastes from healthcare centres (Tudor *et al.*, 2005). Currently, considerable gaps exist with respect to healthcare waste management practices specifically in Nigeria as well as in other sub-African countries when compared to global standards. According to Farzadika *et al.*, (2009), the nature and quantity of waste generated in public healthcare institutions as well as its sustainable management still remains poorly examined and documented despite the health risks involved. The level of awareness particularly of healthcare workers regarding healthcare waste is also not properly documented and remains a major concern.

Globally, the amount of hospital waste generated was projected to quadruple by 2025 (Aker, 2000). Advances in medical facilities with the introduction of sophisticated instruments have further increased the waste generation per patient in health care units (Orloff and Falk, 2003). The stringent environmental controls and legislation on hospital waste even in places like the United Kingdom (UK) have only ensured high standards of waste disposal but failed to decrease the amount of hospital waste generated there (Tudor *et al.*, 2008). In 2002, the World Health Organization (WHO) conducted a survey to assess ongoing hospital waste management in 22 developing countries and showed that the proportion of appropriate waste disposal methods was between 18 and 64%. A study of 120 primary health care (PHCs) centres in Iran concluded that the management of waste materials faced a myriad of problems involving staff training and awareness, separation of hospital waste, establishment of autoclave method for hospital waste treatment, construction of septic tanks and disinfection units in the centres (Al-Khatib *et al.*, 2005).

In another survey at 91 healthcare facilities in southern Brazil, it was found that aside from sharp waste, little attention was given to the management of other types of hospital waste (Da Silva *et al.*, 2002). In many countries, hazardous and hospital wastes are still handled and disposed together with domestic wastes, thereby posing a great health risk to municipal workers, the public and the environment. A previous study in a tertiary institution in India showed that the segregation and storage of hospital waste is a major problem (Pandit *et al.*, 2005). Hospital waste needs to be separated from municipal waste, but in many parts of Africa, it tends to be collected along with the rest of the waste stream (Alemayehu *et al.*, 2005). In Tanzania, hospital waste management was described as being poor and that general awareness on issues related to hospital waste management was generally lacking among generators and handlers (Manyele *et al.*, 2003). The scenario of poor hospital waste management was found to be the same in South Africa, Mozambique, Swaziland and Kenya (Manyele, 2004). In Ethiopia, it was observed that the management of hospital waste was poor, accompanied by low level of training and awareness of waste legislation prevalent amongst staff (Manyele *et al.*, 2003). In the Kwazulu Natal Province of South Africa, about 45% of hospital waste generated could not be accounted for while a general lack of adequate capacity to properly manage hospital waste also existed (Manyele, 2004).

A study carried out in Ibadan, Nigeria revealed that there is a near total absence of institutional arrangement for hospital waste (Coker *et al.*, 2002). In Lagos state, a study of four hospitals (2 private and 2 public) revealed that none of them had the following: tracking program, abatement facility and even a hospital waste management plan to ensure proper disposal of hospital waste (Longe and Williams, 2006). A study in Port Harcourt showed that only 1% of PHCs had a transport vehicle while only 8% had established dumpsites (Stanley *et al.*, 2011). More than 90% of the hospital waste generated in Nigeria is directly disposed on land

in an unsatisfactory manner (Lekwot *et al.*, 2012). Information on the amount of hospital waste and its management practices is rather nonexistent in spite of the hazards and epidemiological implications (UNDP, 2003).

There are potential risks to the environment and health from improper handling of hospital waste and specific risks in handling wastes from hospitals and clinics. For the general public, the main risks to health are indirect and arise from the breeding of disease vectors, primarily flies and rats (UNDP, 2003). Pathogens present in waste can enter and remain in the air within the hospital for a long period, in the form of spores or as pathogens themselves. This can result in hospital-acquired infections (nosocomial infections) or occupational health hazards.

Exposure to hazardous waste can be as a result of accident, ignorance, nonchalance or deliberate negligence on the part of waste handlers (UNDP, 2003). Therefore, the healthcare workers (doctors, nurses, administrators), visitors, waste disposal crew and scavengers at dumpsites stand the risk of being infected when hospital waste management is not conducted with a satisfactory degree of safety in many parts of the globe, especially in the developing world (Taru and Kuvarega, 2005). Against this background, this study examined staff knowledge, awareness and practice of medical waste management at Murtala Mohammed Specialist Hospital, Kano. Also, the level of compliance to the United Nations recommended sustainable practices was evaluated.

2. MATERIALS AND METHODS

2.1. Area of the Study

Murtala Muhammad Specialist Hospital (MMSH) is the premier health institution of Kano State, Nigeria. It serves as both a specialist and a referral centre to almost all the hospitals in the state, including neighbouring Bauchi, Jigawa, Kaduna and Katsina states as well as the neighbouring countries like Niger Republic, Chad and Benin Republic (MMSH, 2018).

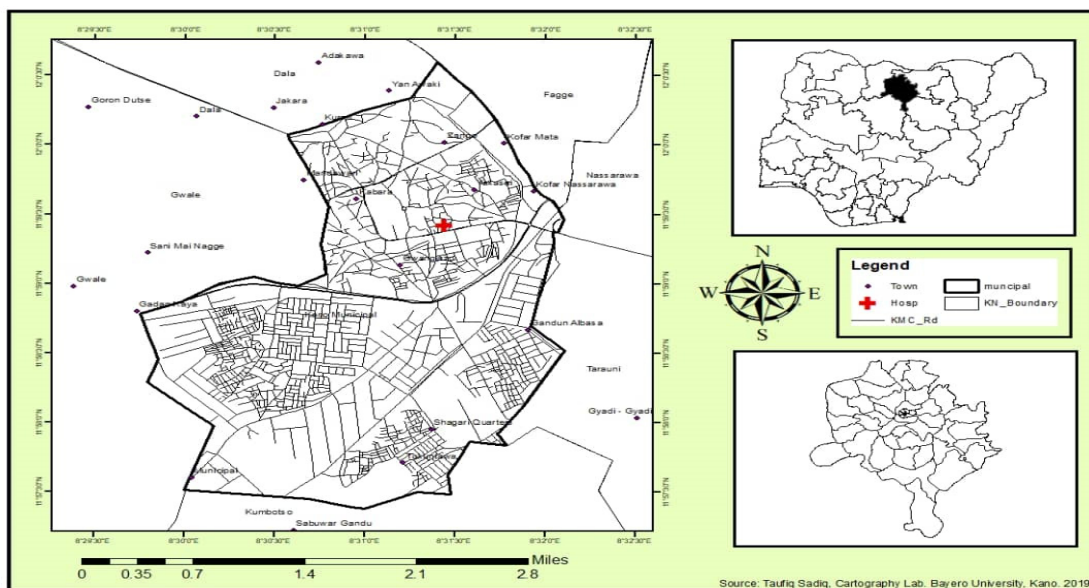


Figure 1: Murtala Mohammed specialist hospital, Kano

The hospital was commissioned in 1926. Presently with an official bed capacity of 826, it has a total number of 30 wards and units, 9 operating theatres and 14 clinics with staff strength of 1,656. It is also an NHIS (National Health Insurance Scheme) accredited hospital. This facility caters for a substantial part of the Kano population.

2.2. Methodology

This cross-sectional descriptive study was conducted between January and April 2019. Structured questionnaires as approved by the environmental health unit of the hospital were administered, including personal interviews and physical assessments. In the process of conducting the study, the data collected through responses given in the questionnaires were analyzed and interpreted using descriptive statistics.

The study population consists of the healthcare workers of MMSH, Kano. A total of 50 structured questionnaires were administered to respondents in different departments of the hospital and deemed sufficient to achieve the research objectives satisfactorily. 10 personal interviews were conducted with staff of the environmental health unit and other departments in the hospital. Physical assessment of medical waste in the hospital was also conducted through site visits. Simple random sampling technique was adopted in selecting the respondents based on voluntarism and informed consent. Health workers involved in generation and management of HCW included doctors, midwives, nurses, community health officers, community health extension workers and environmental health officers. Workers in MMSH who were not healthcare personnel were excluded from the study. These included administrative staff and security personnel. Data collected were checked for completeness, cleaned, coded and analyzed using the Statistical Package for the Social Sciences (SPSS) software.

3. RESULTS AND DISCUSSION

Shown in Table 1 are the departments where the respondents work and 36% of them belong to the environmental health unit, 10% are accident and emergency staff, 14% are from the department of medicine, 4% from the community health unit, 4% from physiology department, 2% from the pharmacy department, 6% from the laboratory unit, 8% from the maternity unit and 16% from the orthopedic department.

Presented in Table 2 is the cadre of the staff that participated in the study. Most of the respondents (36%) are environmental health officers, 4% are community health officers, 6% community extension health officers, 2% junior community health extension officers, 20% nurses, 8% midwives, 6% laboratory technicians, 6% pharmacy technicians and the remaining 14% belong to other cadres.

Table 1: Respondents' working department

| Departments | Percentage (%) |
|----------------------|----------------|
| Environmental health | 36.0 |
| Accident & emergency | 10.0 |
| Medicine | 14.0 |
| Community health | 4.0 |
| Physiology | 4.0 |
| Pharmacy | 2.0 |
| Laboratory | 6.0 |
| Maternity | 8.0 |
| Orthopedics | 16.0 |
| Total | 100 |

Indicated in Table 3 is the respondents' awareness about the existence of hospital waste management policy. There seems to be neutral knowledge of the awareness of the existing hospital waste management policy in the facility. Only one half of the staff are aware of the existence of such policy. According to Rouyan *et al.* (2010), educational background and training experience are factors that could affect staff knowledge about healthcare waste management policy in a facility. Lack of awareness of hospital waste policy could also be due to individual staff attitudes or organisational lapses. However, staff awareness could be improved through publicity campaigns using seminars and workshops.

Represented in Table 4 is the participants' exposure to hospital waste management training. Majority (66%) of the staff have not had any training while 34% claim to have received training. Abah and Ohimain, (2011) have reported management commitment as a critical factor in healthcare waste management. Staff training may not be a priority for management authorities. Inadequate funds could also determine if trainings are conducted due to so many competing needs.

Table 2: Respondents' cadre

| Items | Percentage (%) |
|---|----------------|
| Environmental health officer | 36.0 |
| Community health officer | 4.0 |
| Community extension health officer | 6.0 |
| Junior community extension health officer | 2.0 |
| Nurse | 20.0 |
| Midwife | 8.0 |
| Laboratory technician | 6.0 |
| Pharmacy technician | 4.0 |
| Others | 14.0 |
| Total | 100 |

Table 3: Knowledge about the existence of hospital waste management policy

| Response | Percentage (%) |
|----------|----------------|
| No | 50 |
| Yes | 50 |
| Total | 100 |

Table 4: Participants exposure to waste management training

| Response | Percentage (%) |
|----------|----------------|
| No | 66.0 |
| Yes | 34.0 |
| Total | 100 |

Shown in Figure 2 are the types of hospital waste the respondents have knowledge about. All (100%) are aware of infectious waste, while only 24% of them know pathological waste. However, only 58% are aware of sharps waste; 56% are aware of chemical waste; 34% are aware of pharmaceutical waste. From the itemized responses, 18% revealed that they are aware of cytotoxic waste while just 4% responded to the awareness of the existence of other types of healthcare waste. The disparity shown in knowledge could be due to non-exposure to essential training in waste management.

Figure 3 represents the participants' knowledge on the components of hospital waste management. Here, 24% consider waste minimization as a component of waste management, 40% mentioned segregation while 36% have knowledge of temporal storage. In addition, 46% stated transportation and 22% claimed knowledge of only waste treatment. Finally, 68% are aware of disposal as a component of hospital waste

management. This could be directly related to majority of staff lacking training in waste management. Training is necessary if staff are to understand the components of waste management.

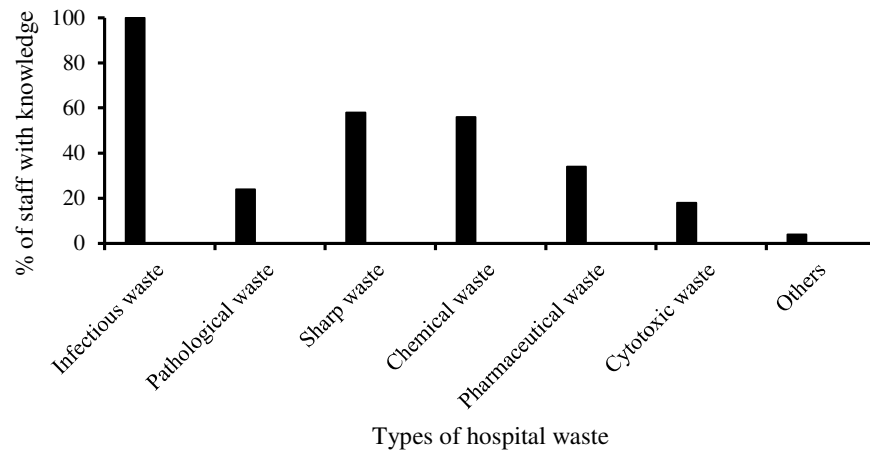


Figure 2: Participants knowledge of types of hospital waste

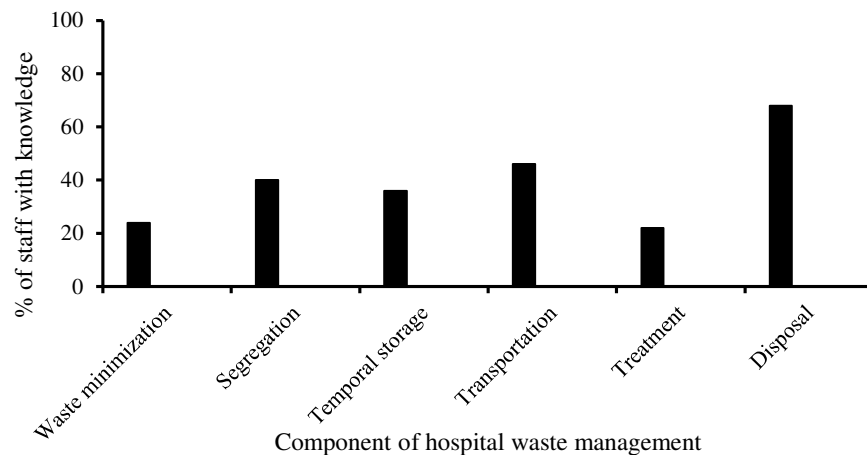


Figure 3: Participants' knowledge on the components of hospital waste management

Shown in Table 5 is the perceived rationale behind the non-segregation of hospital waste into different categories. Results show that 96% of participants do not know why the waste in the hospital is not segregated while the remaining 4% claim lack of awareness of waste segregation activities. The practice of waste segregation may not be practiced without knowledge of its significance which majority of staff lack. However, staff can be stimulated into action through education and training.

Table 6 above is respondents' awareness of colour coding for waste disposal in the hospital. Majority of staff (70%) seem to have knowledge of the colour codes for waste disposal. However, a little above a quarter (30%) are not aware of it within the hospital premises. Some of staff in the hospital have not had any formal

training on healthcare waste management may explain why 30% do not have the knowledge or practice colour-coding.

Highlighted in Table 7 is the availability of hospital boxes for storing sharp wastes in the facility. Majority (72%) of participants attest to the availability of the boxes. However, 8% do not know about it while about 20% reported that sharps disposal boxes are not used in the hospital. This means safety boxes are provided for sharp waste disposal. However, staff attitude plays a significant role in waste management practice and this may explain why some staff do not know if safety boxes are provided in the facility.

Table 5: Reasons why the hospital does not segregate waste into different categories

| Responders | Percentage (%) |
|-------------------|----------------|
| Don't know | 96 |
| Lack of awareness | 4 |
| Total | 100 |

Table 6: Information on awareness of colour code for hospital waste for disposal

| Responses | Percentage (%) |
|-----------|----------------|
| No | 30 |
| Yes | 70 |
| Total | 100 |

Table 7: The availability of safety boxes for storage of sharp waste in your facility

| Response | Percentage (%) |
|------------|----------------|
| Yes | 72 |
| No | 8 |
| Don't know | 20 |
| Total | 100 |

Represented in Figure 4 is the length of time waste remains on-site before collection. Most participants (64%) said 12 hours, 20% stated 13-24 hours, 4% mentioned 25-48 hours while 10% reported up to 49-72 hours. However, about 2% are not aware of how long waste remains uncollected. Differences in waste collection timelines may be due to the fact that the cleaners or waste collectors in the hospital work on shifts. Therefore, waste evacuation is done routinely to coincide with when workers arrive or about to close for duty. Administrative monitoring by management is needed to improve waste handling practices (Rouyan *et al.*, 2010). Adequate monitoring could ensure timely evacuation of waste.

Shown in Figure 5 are the methods employed to transport waste within the premises. Most (48%) reported the use of trolley; 40% mentioned wheelbarrows; 10% reported the application of bare hands while 2% did not specify any particular means of waste transport within the premises. Workers probably use what is available to transport healthcare waste within the hospital premises. The transportation of waste is usually left to uneducated and unskilled labourers that may not be concerned with method of transportation.

Represented in Figure 6 is the combination of the methods of the final disposal adopted by the hospital. Majority (40%) reported burning, 30% stated hospital waste is buried, 15% cited open dumping and 5% reported that the sanitary landfill method of final disposal is adopted by the hospital. Burning, burying and open dumping seem easier and cheaper to adopt compared to landfills. The management of municipal waste is a persistent problem in the country compounded by lack of functional landfills (Abah and Ohimain, 2011). Other contributing factors include poor road network, transport vehicles and effective waste disposal system.

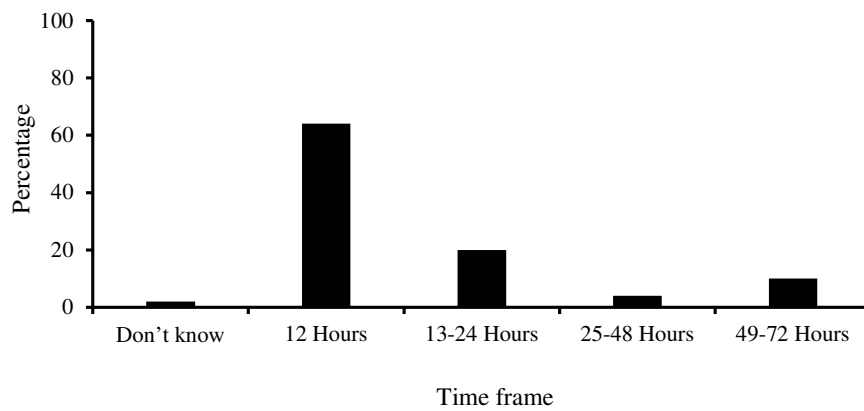


Figure 4: The period of time waste stays on-site

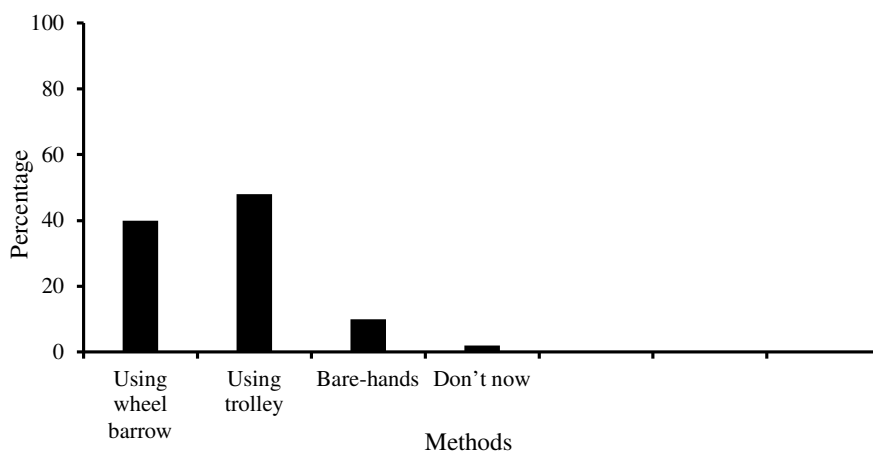


Figure 5: Methods of hospital waste transportation within the hospital

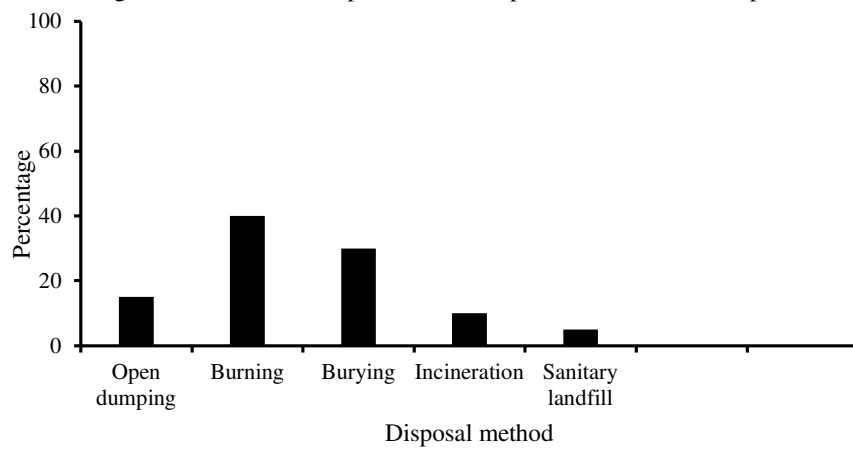


Figure 6: Methods of final disposal in the hospital

Table 8 shows the variations of facility practices in Murtala Mohammed specialist hospital when compared to global standards. The challenges faced in management of hospital waste are enormous, starting from the point of generation to final disposal. There are problems of staff training gaps and between basic and known facts and general practice of healthcare waste management. In a study carried out by Longe et al. (2009) in Lagos, it was discovered that most hospitals had no record of the volume of waste generated by them. Lack of management commitment, poor waste handling practices, inadequate training on hospital waste management, nonexistent segregation of hospital waste and risky disposal practices have also been reported by Abah et al. (2003). National legislation and policy specific to hospital waste management are yet to be implemented at any level despite the existence of policies on HCW management. Other factors contributing to poor hospital waste management include the general situation of infrastructure, such as poor roads, intermittent electricity and lack of health vehicles (thus making the transportation of waste unsafe) and the absence of an effective municipal waste system (Al-Khatib et al., 2005).

Table 8: Comparison of waste management practices in the hospital to global standards (United Nations Conference on the Environment & Development-UNCED)

| S/N | Activity | UNCED Standards/Recommendations | MMSH Practices |
|-----|-----------------------------------|---|---|
| 1. | Staff knowledge and awareness | -All medical staff should have basic knowledge and training on waste management. -Availability of policy manual/ document. -Availability of Information, Education & Communication (IEC) materials/ Standard Operations Procedures (SOPs). | -Neutral knowledge of waste management reported (50%). -Most staff not trained on waste management (66%). -Most staff (80%) reported awareness of a hospital waste management policy. -No printed manual cited. -Scanty use of SOPs and IEC materials. |
| 2. | Waste minimization | Source reduction: purchasing restrictions to ensure the selection of methods or supplies that are less wasteful or generate less hazardous wastes. Recyclable products: use of materials that may be recycled and reused. Waste segregation: separation of waste materials into different matter sizes. | -Low evidence of deliberate attempt at waste minimization (24%) -Most medical waste in the hospital are not recyclable. -High level of compliance with waste segregation option (88%) indicated by staff but not evidenced practically. |
| 3. | Handling and transportation | -General healthcare wastes should join the stream of domestic wastes for disposal. -Sharps should also be collected together whether or not they are contaminated. -Bags and containers for infectious wastes should be marked with international infectious substance symbol. -Highly infectious wastes should however when possible be sterilized immediately by autoclaving. -Small amount of chemical or pharmaceutical wastes should be collected with infectious wastes. | -Most of the medical waste is transported off-site and mixed with municipal waste for disposal. -Availability and use of safety boxes for sharps disposal is high (72%) but not used exclusively. -Knowledge of infectious waste is high (100%), colour coding knowledge (70%) although mostly not practiced except in the laboratory unit. -Infectious waste not properly marked and labelled. -Minimal use of sterilization by autoclaving (8%) indicated but not evidenced. -Infectious waste from the hospital has pharmaceutical waste content. |
| 4. | Collection | -Nurses and health staff should ensure that collection of wastes from wards should be made when they are three quarter full. -No bags should be removed unless they are labelled with their source of production (hospital and ward or department) and content. -The bags or containers should be replaced with new ones immediately after collection. | -Wastes are evacuated based on cleaning schedule and not based on fullness of containers. -No evidence of waste labelling in the hospital. -No indication of the immediate replacement of bin bags after waste collection. |
| 5. | Storage | -A storage site for wastes should be designated inside the healthcare location or establishment and the wastes in bags and containers should be stored in separate rooms or areas according to the quantities and frequency of wastes produced. -Unless a refrigerated storage is available, storage times for healthcare wastes should (i.e. the delay time between production and treatments) should not exceed the following: Temperate climate- 72 hours in winter 48 hours in summer. Warm climate- 24 hours in hot season 48 hours in the cool season. | -No designated and separate storage room or area for generated waste. -No refrigerated storage facility is available in the hospital. |
| | | Cytotoxic wastes should be stored separately from other wastes in a designated secure location. -Radioactive wastes should be stored in containers that prevent dispersion behind lead shielding. -Wastes that is to be stored during radioactive decay should be labelled with the type of radionuclide the date and details of the required storage condition. -Handling and disposal facilities should hold a permit issued by a waste management authority. | -Evacuation time is usually less than 24 hrs (84% of the time). Waste sometimes stays beyond 24 hrs (10%) of the time. -No special storage of cytotoxic waste is implemented. -Radioactive waste is generated and collected separately but not in special containers. -Radioactive waste is not properly labelled in the hospital. - No evidence that the hospital has a disposal license. |
| 6. | Health personnel and staff safety | -Training for a comprehensive risk assessment of all processes involved in handling of potentially hazardous materials. -Protective clothing depending on the risk and hazard depending on the extent of the hazard associated with the healthcare worker wastes. -Immunization and response to injury and exposure. | -No evidence of risk assessment reports in the hospital. -High level of conformity with the use of protective clothing depending on area of operation and procedure performed. -No proper documentation on exposure, immunization, injury and treatment. |

The findings of this study are consistent with results from previous studies conducted in other developing countries. There are similarities in both environmental settings and socio-economic statuses and their approach to waste management. According to Kumar et al. (2017), effective waste management is a major challenge in developing countries. Despite significant development in social, economic and environmental areas, waste management systems have remained relatively unchanged, including collection, storage, segregation, transportation, processing and disposal. There is generally a low level of compliance to the minimum global standards of medical waste management in MMSH, Kano. The study by Kumar et al. (2017) points out that local authorities responsible for managing waste have budgets that are insufficient to cover the costs associated with developing proper waste collection, storage, treatment and disposal. Moreover, the major barriers to achieving effective waste management include the lack of strategic waste management plans, waste collection and/or a segregation structure and a sustainable government finance regulatory framework. There could also be lack of facility management commitment and direction on HCW management. Limited environmental awareness combined with low motivation has inhibited innovation and the adoption of new technologies that could transform effective medical waste management. Public and staff attitudes to waste also constitute a key challenge to medical waste management.

The provision adequate HCW management facilities may not be a top priority for government hospitals. Policy makers decide what their priorities are and may not include the provision of waste management facilities as their priorities. Other political issues include the diversion of resources due to corruption and the administrative bottlenecks that cause adverse protocols to the implementation of hospital sanitation projects. Interventions involving the sustainable management of HCW can result in better disease management by increasing prevention and reducing illnesses due to infections. It also helps to preserve the environment.

Regardless of the outcome of this research work, further research should investigate the reasons for poor waste management in government hospitals. Additional work in this area would also prove quite beneficial to combine findings and propose and develop sustainable models for sustainable HCW in resource-constrained settings like ours. This provides a good basis for discussion and further research.

The researchers believe that this current trend can be reversed by taking some simple and committed steps. These include:

- More Sanitary health inspectors and community health officers should be deployed to inspect and monitor the waste management process and also help with staff sensitization.
- Adequate sanitary materials, including personal protective equipment (PPE), trolleys, wheelbarrows, colour-coded bins and other waste disposal facilities, such as incinerators, should be provided.
- Continuous health education and awareness training opportunities.
- Proper waste segregation techniques, including proper sorting, recycling and disposal of waste, should be employed.
- Vehicles for transporting wastes to offsite locations should be provided.
- Medical workers should be encouraged to report cases of injuries from used medical waste, such as sharp objects, to ensure prompt treatment and documentation.
- More funding to general medical waste management in government hospitals.

4. CONCLUSION

The study found that even though a considerable number of staff are aware of the hospital waste management policy, most remain untrained in medical waste management. There is also a low level of compliance to standard waste management practices, including waste segregation, treatment and final disposal. The most common practice of final waste disposal is incineration or burning followed by burying. The widespread practice of these methods has been informed by the inability of the hospital to procure the requisite facilities for sustainable waste management. This inability may be due to the paucity of sufficient funds from the state of Ministry of Health. Although the use of burning or incineration is considered safe, its consequence could be in the longer term, as emissions from the burning can pose a threat to the ecosystem and public health. There is therefore the need for the development of better, safer and sustainable means or models of medical waste disposal, especially in government-owned facilities.

5. CONFLICT OF INTEREST

There is no conflict of interest associated with this work.

REFERENCES

- Abah, S.O. and Ohimain, E.I., 2011. Healthcare waste management in Nigeria: A case study. *Journal Public Health and Epidemiology*, 3(3), pp. 99-110.
- Adesina, A.A. and Igbuku, A.O. (1988). Solid Waste Management Shell Petroleum Development Company (SPDC) Approach. *Environmental News*. 5(1), pp. 23.
- Aker, N. (2000). Medical Waste Management: A Review. Engineering Program, School of Environment, Resource and Development and Asian Institute of Technology, Thailand, pp. 34 - 39.
- Alemayehu, E., Tegegin, A., Beyene, G., Workneh, D. and Endeke, H. (2005). Infectious Waste Management for the Ethiopian Healthcare Team, *Ethiopian Journal of Waste Management*, 8 (4), pp. 143 - 149.
- Al-Khatib, I.A., Al-Shayeh, M.S. and Al-Qaroot, Y.S. (2005). Management of Healthcare Waste in Circumstances of Limited Resources: A Case Study of PHCs in Iran. *Waste Management Research*, 27(3), pp. 305 - 312.
- Coker, A.O., Sangodoyin, A.Y. and Ogunlowo, O.O. (2002). Managing Hospital Wastes. In Nigeria; Proceedings of the 24th WEDC Conference, Islamabad, Pakistan. 31st August - 4th September; pp. 70 - 72.
- Da Silva, C.E., Hoppe, A.E., Ravanello, M.M. and Mello, N. (2002). Medical Waste Management in the South of Brazil. *Journal of Waste Management*, 25(6), pp. 600-605.
- Diaz, I.F., Savage, G.M. and Eggerth L.L. (2005): Alternatives for the Treatment and Disposal of Healthcare Wastes in Developing Countries, *Waste Management*, Vol. 25, pp. 626-637.
- Farzadika, M., Moradi, A. and Mohammadi, M.S. (2009). Hospital Waste Management status in Iran: A case study in the Teaching Hospitals of Iran University of Medical Sciences. *Waste Management Research*, 27, pp. 384-389.
- Kumar S., Smith, S.R., Fowler, G., Velis, C., Kumar, S.J., Arya, S., Kumar, R.R. and Cheeseman, C., (2017). Challenges and Opportunities associated with Waste Management in India. *Royal Society Open Science* 4(3): 160764
- Lekwot, V.E., Blama, V.N., Ezemokwe I., Okafor, C.I. and Bawa, A. (2012). Public Health Implementation of Improper Hospital Waste Disposal in Zangon-Kataf Local Government Area, Kaduna State. *Journal of Research in Environmental Science and Toxicology*, 1(2) pp. 23 - 28.
- Longe, E. and Williams, A. (2006). A preliminary study of hospital waste management in Lagos Metropolis, Nigeria. *Iranian Journal of Environmental Health Science and Engineering*, 3, pp. 133-139.
- Longe, E.O., Longe, O.O. and Ukpebor, E.F. (2009). People's Perception on Household Solid Waste Management in Ojo Local Government Area in Nigeria. *Iranian Journal of Environmental Health Science and Engineering*, 6(3), pp. 209-216.
- Manyele, S.V. (2004). Medical Waste Management in Tanzania: Current Situation and the way Forward. *African Journal of Environment*, 8(1). pp. 74 - 99.

- Manyele, S.V., Anicetus, H. and Bilia, M.H. (2003). Globalization and its Effects on Medical Waste Management in Tanzania. *Journal of Waste Management*, 19(4), pp. 576-579.
- MMSH (2018). Murtala Mohammed Specialist Hospital-Kano State Ministry of Health. Available at <https://www.smoh.org.ng>. [Accessed 12 January 2019].
- Orloff, K. and Falk, H. (2003). An International Perspective on Hazardous Waste Practices. *International Journal of Hygiene Environmental Health*, 206, pp. 291 -302.
- Pandit, N.B., Mehta, H.K., Karma, G.P. and Choudhary, S.K. (2005). Management of Biomedical Waste: Awareness and Practices in a district of Gujarat. *India Journal of Public Health*, 4, pp. 245 - 257.
- Patil, G.V. and Pokhrel, K. (2005). Biomedical Solid Waste Management in an Indian Hospital: A Case Study. *Waste Management*, 25(3), pp. 529 -599.
- Ruoyan, G., Lingzhong, X., Chengchao, Z., Jiangjiang, H., Yoshihisa, S., Wei, T. and Chushi, K., (2010). Investigation of health care waste management in Binzhou District, China. *Waste Management*, 30(2), pp. 246 - 250.
- Stanley, H.O., Okpara, K.E., Chukwujekwu D.C., Agbozu I.E. and Nyenke C.U. (2011). Healthcare Waste Management in Port Harcourt Metropolis. *American Journal of Scientific and Industrial Research*, 2(5), pp. 769 - 773.
- Taru, P. and Kuvarega, A.J. (2005). Solid Waste Management: The Case of Palirenjatwa Hospital, Zimbabwe. *Revista biomedical*, 16, pp. 157 - 158.
- Tudor, T.L., Noonan, C.L. and Jenkin, L.E.T. (2005). Healthcare waste management: A case study from the Cornwall NHS, UK. *Waste Management*, 25, pp. 606-615.
- Tudor, T.L., Marsh, C.L., Butler, S. and Van Horn, J.L. (2008). Realizing Resource Efficiency in the Management of Healthcare Waste from the Cornwall National Health Service (NHS) in UK. *Waste Management*, 28 (7), pp. 1209 - 1218.
- UNCED (1992). The United Nations Conference on the Environment and Development (UNCED), Safe Management of Wastes from Health-care Activities. Available at <https://books.google.com.ng/books>. [Accessed 20 February 2018].
- UNDP (2003). Human Development Report, 2003. pp. 2-5. Available at <http://www.ng.undp.org>. [Accessed 22 December 2018].