

Statistical Analysis of Medical Waste Generation, Management and Health Implications in Enugu Metropolis, Enugu State, Nigeria

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Abstract

The study was made to assess the medical waste management practices, to obtain information on the most common health problems associated with medical waste handling and to determine the average volume of medical waste generated in a hospital per day and the total volume generated in all the hospitals per day per month. For this purpose, well structured questionnaires were distributed to the health care managers and waste handlers in each of the 12 randomly selected hospitals (7 publics and 5 privates) in Enugu metropolis. Data for the management practices were obtained through the health care managers while those on health implications were received from the waste handlers and finally those on waste generation were obtained through site visits. Based on the data, it was found that the management practices in all the hospitals surveyed are still below the stipulated standards. The wastes are not appropriately treated before final disposal. Open burning and burial is an uncommon but usual practice in all the hospitals. Using chi-square test, it was found that significant difference exist between the most common health problems associated to waste handling as regards the waste carriers and the final disposers, 85.3% of the waste carriers (cleaners) indicated of having tiredness or headache or pains while 78.7% of the final disposers indicated of having catarrh or cough or tiredness. Using a *t*-test for difference of two means, no significant difference was found between private and public hospitals as regards waste generation. On average, between 185.3 and 299.7 kg of medical waste is generated in each of the hospitals per day while a total of 3367.3 kg to 7302.3 kg is generated in all the 22 identified hospitals in Enugu Metropolis per day resulting in a total generation of 101,031.9 to 219068.1 kg per month.

Key words : Medical waste, Management, Disposal, Enugu metropolis.

Medical waste (MW) is a hazardous waste, second to radioactive waste. The improper management and disposal of MW causes serious health and environmental problems in terms of air, water and land pollution (1). Though MW constitutes a small fraction of the municipal solid waste (MSW), the potential environmental and health hazards could be extremely dangerous if not properly handled. The worst case scenario of MW management is in developing countries (2). Among the developing countries where medical waste management (MWM) are far from being satisfactory, the situation appears to be more critical in Africa as reports from around the continents indicate poor MWM practices (1, 3). Longe and Williams (4) assessed MWM practices in Lagos metropolis in Nigeria and discovered that in all the hospitals surveyed, there were indication of absence of full compliance with the protocols for handling MW as stipulated in the relevant sections of the guidelines

and standards for environmental pollution control in Nigeria. They discovered that burning and burial of MW is an unusual but common practice in the hospitals and also that most of the hospitals surveyed do not appropriately treat their waste before final disposal. Further, they estimated the total MW volume generated in the hospitals to be 611.5 kg/per day and 18,345 kg / per month by all the surveyed hospitals in Lagos metropolis. According to Manyele (5), MW generation is high and is increasing in Tanzania reaching up 0.75 kg/bed per day on average. Given the large number of beds in the country, it is obvious that MW requires immediate attention. Hospital waste handling is a hazardous waste activity which requires a high standard. It calls for specific training that depends on the nature of the work in the hospitals, the hazards and possibility of worker and the responsibilities of the individual workers (6, 7). Considering the increasing MW generation in the country and

Table 1. Waste generation in government (Y) and private (X) hospitals per day (approximated to the nearest kg). T-value for *t*-test for difference of two means = 0.59. The critical value at 5% level of significance with 10 degrees of freedom = 2.23. Thus the null hypothesis of no significant difference between the volume of waste generated in the two categories of the hospitals is accepted against the alternative hypothesis of significant differences, since (T-value = 0.59 < critical-value = 2.23).

| | y_i | x_i |
|--------------------|-------|---------|
| | 200 | 250 |
| | 100 | 90 |
| | 160 | 200 |
| | 220 | 140 |
| | 300 | 400 |
| | 300 | |
| | 550 | |
| Mean | 261 | 216 |
| Standard deviation | 146 | 119 |
| n_y | 7 | n_x 5 |

Overall : $n = n_y + n_x = 12$, Mean $\bar{y} = 242.5$, Standard deviation $s = 131.8$, $s^2 = 17365.9$

mindful of the low-class management practices and the health risks associated with MW handling, this study was made to study the MWM practices and the total volume of MW being generated by the hospitals in the Enugu Metropolis per day / month and the most common health problems associated with MW handling. Here MW handlers would be classified into two namely, carriers and final disposers. Carriers are those that clean the hospitals, collect the waste with plastic buckets / waste bins / bags and dump them at a collection point before treatment and final disposal while the final disposers are those that treat / burn / bury the waste.

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Study Area

The study area, Enugu urban area, is the capital of Enugu state and was once the capital of the former eastern region. The area lies approximately within latitude $6^\circ 20''$ N and $6^\circ 30''$ N and longitude $7^\circ 20''$ E and $7^\circ 20''$ E and is bounded by several other states ; in the north by both Benue and Kogi

Table 2. Common health problems as indicated by the waste managers. A total of 200 questionnaires were distributed to the waste managers, only 191 were recovered, amounting to a 95.5% response rate. $\chi^2_{-value} = 50.56$; degrees of freedom = 4 ; P -value = 0.00 ; critical -value = 9.49. Since $\chi^2_{-value} = 50.56 >$ the critical-value = 9.49, we reject the null hypothesis of no difference between waste handling and the associated common health problems in favor of the alternative hypothesis of significant difference.

| Common health problems | Cleaners | Final disposers |
|------------------------|------------|-----------------|
| Headache | 17 (14.7%) | 11 (14.7%) |
| Pains | 62 (53.4%) | 9 (12.0%) |
| Tiredness | 20 (17.2%) | 13 (17.3%) |
| Catarrh | 7 (6.0%) | 17 (22.7%) |
| Cough | 10 (8.6%) | 29 (38.7%) |
| Total | 116 | 75 |

states, in the south by Abia and Imo states while in the west and east by Anambra and Ebonyi states respectively. The official population figure of Enugu urban area, from the 2006 population census stands at 722,664 (8).

Methods

Out of the 22 identified hospitals in the Enugu metropolis comprising government and private owned hospitals, 12 were randomly selected. Within the 12 selected hospitals seven were government owned while five were private owned. Government owned hospitals are called public hospitals while private owned ones are called private hospitals. Data for the study were collected from the 12 selected hospitals through the distribution of a simple and objective questionnaire as follows.

Data on waste generation were collected through site visits. Each of the selected hospitals were visited once for this purpose and all the collected waste in plastic containers, dust bins and plastic buckets and so on, were each put on a measuring device and the weights carefully taken.

Data on the prevalent health problems associated with MW handling were distributed to the waste handlers (carriers and final disposers) in each of the hospitals. Finally, data on waste management practices were obtained by distributing questionnaires designed based on the guidelines of the safe management of waste for health care facilities (2) to the health care managers in each of the hospitals.

Table 3. Waste management practices as indicated by the hospital management. $Y_i, i = 1, 2, \dots, 7$ = Government hospital and $X_i, i = 1, 2, \dots, 5$ = Private hospital.

| Hospital | Storage / Disposal | | | | Method of waste treatment | Existence of tracking and monitoring systems |
|----------|--------------------|------------------|-------------------|-----------|---------------------------|--|
| | Regulated waste | Infectious waste | Sharps | Chemicals | | |
| Y_1 | Plastic buckets | Seal in bags | Containers | Sink | Open burning | No |
| Y_2 | Waste bins | Waste bags | Containers | „ | „ | „ |
| Y_3 | Bags | Bags | Safety boxes | „ | Incineration | Yes-supervisors |
| Y_4 | Bags | „ | Safety Containers | „ | Open burning | No |
| Y_5 | Disposable bags | „ | Waste bin | „ | „ | „ |
| Y_6 | Bags | Waste bins | Safety boxes | „ | Incineration | Yes-supervisors |
| Y_7 | Waste bins | Plastic buckets | Containers | „ | Open burning | No |
| X_1 | Disposable bags | Waste bins | Containers | Open pit | „ | „ |
| X_2 | Bags | Disposable bags | Safety boxes | „ | „ | „ |
| X_3 | Waste bins | Bags | Disposable bags | Sink | „ | „ |
| X_4 | Bags | „ | Rubber buckets | „ | „ | „ |
| X_5 | Plastic buckets | Rubber buckets | Safety boxes | „ | „ | „ |

Results and Discussion

A preliminary analysis was carried out on the volume of waste generated per day on the selected hospitals. Here a *t*-test for difference of two means was used to determine if there exist significant difference between the volume of MW generated by government and private owned hospitals so as to deal with them differently. It was discovered that there is no significant difference between the volumes of MW generated in both categories of hospitals and as a result, the data from both categories of hospitals were handled together (Table 1).

Considering that the sample selection of the surveyed hospitals was done using a simple random sampling method without replacement, 95% confidence interval was constructed for average daily volume of MW generated per hospital and the total volume generated in all the hospitals in Enugu Metropolis per day using.

$$\bar{y} \pm t_{\alpha/2} \frac{S_{\bar{y}}}{\sqrt{n}} \quad \dots (1)$$

and

$$\bar{y} \pm t_{\alpha/2} \frac{S_{\hat{y}}}{\sqrt{n}} \quad \dots (2)$$

respectively (9), with

$$S_{\bar{y}} = \sqrt{\frac{N-n}{N} s^2}; \quad s^2 = \frac{\sum_{i=1}^n (y_i - \bar{y})^2}{n-1} \quad \text{and}$$

$$S_{\hat{y}} = \sqrt{\frac{N^2 (N-n) s^2}{(N-1) n}} \quad \dots (3)$$

Substituting the results for the overall in Table 1

into (1), (2) and (3), we obtain the following confidence intervals

$$242.5 \pm 57.19 \text{ kg} \quad \dots (4)$$

and

$$5335 \pm 1967.27 \text{ kg} \quad \dots (5)$$

for the average daily MW generated per hospital and the total generated in all the hospitals per day respectively. The implication is that between 185.3 and 299.69 kg of MW is generated in each of the hospitals per day on the average while a total of 3367.73 to 7302.27 kg is generated in all the 22 identified hospitals in Enugu metropolis per day. This amounts to the generation of between 101031.9 to 219068.1 kg of MW per month.

By the Chi-square test of independence, it is found that there is a significant dependence of common health problems on the category of waste handling. It is seen that greater percentages (14.7, 53.4 and 17.2%) of the cleaners indicated of having headache, pains and tiredness respectively while that of final disposers (17.3, 22.7 and 38.7%) respectively indicated of having tiredness, catarrh and cough (Table 2). This could be explained by the reason that the waste carriers (cleaners) manually lifts the MW collected in bags / buckets / waste bins to the collection points before final disposal and as a result are prone to be tired, have pains and headache as a result of stress. The majority (85.3%) of them indicated tiredness or headache or pains as their most common health problems. On the other hand, the final disposers are prone to have cough and catarrh resulting from the inhalation of toxic gaseous substances released through the open burning of the waste materials. The majority (61.4%) indicated having cough or catarrh as the most common health problems.

The adequacy or inadequacy of the waste management practices of the surveyed hospitals were measured against the principal criteria as stipulated in the national guidelines for the management of medical waste. These include the presence of a tracking program and monitoring and the existence of any medical waste management plan in place. Results revealed absence of tracking and monitoring programs in all the surveyed hospitals except two that use supervisors (Table 3). As a result there is an absolute absence of a sound tracking and monitoring programs

in all the surveyed hospitals. This finding is in agreement with the study of Longe and Williams (4).

On the storage / disposal of regulated, infectious, sharps and chemical wastes, the practice is low-class and is almost the same in all the hospitals. Sharps, regulated and infectious wastes are stored in either plastics buckets or disposable bags or waste bins or rubber buckets without a clear distinction of what is what. With regard to chemicals, the practice is crude and dangerous. Chemicals are either disposed through a sink which goes to an underground pit or disposed into an open pit (Table 3) and this poses a potential environmental hazard through the contamination of surface and groundwater resources.

As regards waste treatment, open burning is an unusual but common practice in all the hospitals except two that incinerates using local incinerators made from bricks. The practice of open burning is tantamount to soil and air pollution as a result the release of toxic material / gases into the air and underground and this poses a potential health risks. No wonder while majority of the final disposers have cough and catarrh as their most common health problems (Table 2). The management practices / disposal methods – open pit burning, burying and incineration is similar to the practice in Tanzania (10). When MW is treated by open burning or incineration, various compounds are usually emitted. These include harmful gases such as (oxides of sulfur, oxides of nitrogen, carbon dioxide) and suspended particulate matter which may contain heavy metals. When these gases are inhaled, they can cause respiratory diseases such as cough and catarrh.

Relative health risks associated with the combustion of MW continue to be debated as data remains limited. A thorough examination of health and environmental risks posed by different pollutant is important (11, 12). It is therefore necessary to identify those pollutants of primary concern in MW incineration / open burning because of their potential human health and environmental impacts.

This study revealed that the inadvisable transfer of MW from the source to the final disposal site manually with waste bins or buckets, is still the practice in all the hospitals surveyed although this depends on the treatment methods as well. For instance,

carrying waste in waste bins or rubber / plastic buckets is not advisable if the waste is to be fed into the combustion chamber of De Montfort. Incinerator, because the operator will have to drain and distribute the waste into small parts before it can be fed into the chamber although as of now, none of the hospitals is using the said incinerator.

Conclusion

This study revealed that the MW management practices are below the stipulated standard and thus there is need for an urgent improvement on the current practices. Medical waste requires proper monitoring for an effective tracking at all times. Control of medical waste can only be fully achieved when adequate monitoring facilities are available. Control means that competent authorities can act rapidly to ensure the possibilities of minimizing inappropriate handling and dumping of MW. It also translates to mean that regulatory should have the powers both legally and financially, to act quickly to reduce dangers posed to human health and the environment. To enhance adequate monitoring and control of MW in Nigeria, governments at the national and state levels need a comprehensive guideline on MW management other than what is currently in existence. Also there is an immediate need to train all handlers of MW on methods and new techniques to adopt in effective waste management practices using WHO manual (13).

Personal protective equipment (PPE) such as masks, respirators, gloves, protective suits, goggles and so on should be made available to the waste handlers so as to reduce their risk of exposure to these hazardous materials. They should also be trained on how to make proper use of these PPE.

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