Management of Health-Care Waste: A Case Study of Two National Teaching and Referral Hospitals in Kenya

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Abstract
It may be necessary for a Public health institution to segregate hospital waste in order to facilitate collection and disposal. In addition, this would save on treatment cost by setting appropriate waste minimization strategies, minimize environmental pollution and hence reduce risks to public health. This would also, provide accurate planning data for health care waste minimization and hence promote public health in all health facilities. The study was done in Kenyatta National Hospital, Nairobi and Moi Teaching and Referral Hospital, Eldoret. This was Analytical study design covering four waste categories. The samples were taken on infectious; pathological; sharps and chemical waste from wards and other units. The weights of the samples were taken daily for seven (7) consecutive days, during the wet and dry seasons. Their quantities and generation rates based on bed capacities in each institution were computed. Kenyatta National Hospital was found to be generating 0.61 kg/bed/day and Moi Teaching and Referral Hospital, 1.03 kg/bed/day. The study determined that Health-care waste was not well segregated in the two National teaching and Referral Hospitals. Therefore, it was recommended that the two Institutions should do regular weighing of the segregated waste categories and maintain records in order to monitor progress in generation rates. Further analytical research should be done to determine the extent of the problem in the other hospitals of Kenya.

Keywords: health-care waste; waste segregation; categorization. quantification.

INTRODUCTION
Health care waste is hazardous material which forms 10% to 25% of the total waste generated in a healthcare institution (WHO, 1994; WHO; 1999). It is generated during patients diagnosis, treatment or immunisation (Rutala & Maryhall, 1992). If not properly managed, it may pose a big public health problem to healthcare workers, the patients and the general public. In Japan, 1987, two interns were fatally injured by needles used on patients infected by a virulent mutant of hepatitis- B, (WHO,1994).

Development of health care sector has been prominently guided by values such as patient /personnel safety and service quality. The efforts to minimise environmental impacts caused by health care wastes are sometimes not prioritised. (Karlsson and Ohman, 2005). In addition, some cultural practices as observed by Pruess et al. (1999), interfere with proper management of the waste. The commentator notes that in Asia religious beliefs require that human body parts are returned to a patients’ family in tiny coffins to be buried in cemeteries. Literature review shows that some relatives demand that amputated body parts of their relatives be returned to them for burial.

It is generally known that management of health care waste is a tedious, foul, difficult, expensive and complicated exercise.. Proper handling of waste during storage, transportation, treatment and disposal is therefore important. Poor management of health care waste can cause significant inconveniences and become a health risk to the population (Sheshinski, 2002; WHO, 2005). It has been observed that health care waste has more heavy metals than Municipal solid waste ( Sabiha-Javied and Tufail, 2008; Zhao et al., 2008; Zhao et al., 2010). This makes categorization and quantification necessary to enable decision-making on safe and effective treatment. In this way, segregation, categorization and quantification support health-care waste minimization. In the same way, it supports environmental protection efforts, occupational safety and, regulatory compliance.. Source reduction of health-care waste is therefore a necessary undertaking that may support this endeavour. It encompasses material elimination, change or product substitution, technology or process change, good operating practice and preferential purchasing “green purchasing” (WHO, 2005; Drain et al., 2003; Takeuchi et al., 2005).

Management of health care waste should be sustainable, environmentally safe, economically affordable and socially acceptable, (Woolridge et al. 2005). This is possible if accurate health-care waste generation rates in categories are known. Various
studies recommended that waste categories be standardized for the convenience of its management. Other studies have shown that, Medical waste may be classified into eight categories that includes, infectious, pathological, sharps, chemical, pharmaceutical, genotoxic, radioactive and waste with high metal contents, (WHO 1994; 1999). Further categorizations have been made by Basel Convention describing five categories, (WHO, 2005). Again, USA, Environmental Protection Agency has eight categories (WHO, 1994). Supporting the above, Okeke (2011) also made reference to eight health-care waste categories.

A situation analysis contained in a study by Ministry of health, Kenya (MOH, 2005) revealed that medical waste in urban centers was generally managed as any other waste. Most of the time it is disposed of in crude public dumps such as Dandora site in Nairobi and other solid waste dump sites situated in most municipalities. Safe management of health-care waste is necessary for the promotion of public health.


At the time of conducting this study, the country was in its third year of the Plan implementation. It has gone through the first two annual phases that include consolidation and development stages (2008-2010). However many activities for the first phase had not been implemented in the two referral hospitals under study. The two institutions have commenced waste segregation, storage in labeled and coded containers followed with incineration as medical waste treatment option.

PROBLEM STATEMENT
Various studies recommend that waste categories be standardized and minimized for the convenience of its management. A situation analysis contained in a study by Ministry of health, Kenya (MOH, 2005) revealed that medical waste in urban centers was generally managed as any other waste and hence posing public health risk.

LIMITATION
Due to financial constraints the study was limited to two public and national referral hospitals in Kenya

METHODOLOGY
This was Analytical study design for hospital wastes in two National Teaching and Referral hospitals in Kenya. The medical waste categories generated in various wards and units were segregated into four categories. The four categories under study included, infectious, pathological, sharps and chemical wastes. They were weighed daily and weights recorded for seven consecutive days during the wet and dry season.

The wastes collected covered the following aspects:
- Infectious waste –cultures and stocks of infectious agents associated with biological medical laboratories, waste from surgery, autopsy on patients with infectious diseases, waste from patients in isolation wards or undergoing haemodialysis.
- Pathological waste- tissues, organs, body parts, human foetuses, blood and body fluids.
- Sharps –which could cause a cut or puncture especially needles or blades released after use in patients care, syringes (with or without attached needles). Pasteur pipette, scalpel blades, blood vials, needles with attached tubings and culture dishes (regardless of presence of infectious agents). These were collected in safety boxes.
- Chemical Waste (mainly disinfectants) and other waste considered hazardous, corrosive, flammable, or reactive and/or genotoxic.

In the two institutions, weighing of the four categories of hazardous health-care waste was done at a receiving yard awaiting transfer to the incinerator. The chemical waste recorded as waste was based on supplies to various wards and hospital units during the sampling period as there was no method in place to account for chemicals generated as waste.

The exercise was carried out, (for the dry season), in Kenyatta Teaching and Referral hospital between 15/7/09 and 21/7/09 and Moi Teaching and Referral hospital between 13/6/09 and 19/6/09. For the wet season the seven (7) days samples were taken between 28/10/09 and 3/11/09 for Kenyatta Teaching and referral hospital and 31/10/09 and 6/11/09 for Moi Teaching and Referral hospital.

RESULTS AND DISCUSSION
❖ Kenyatta Teaching and Referral hospital
❖ Wet Season Medical Waste Generation. The following are the summaries of the weighed health-care waste during the seven days of the wet season:-

<table>
<thead>
<tr>
<th>Table 1.0: Quantities of medical waste generated during wet season</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Seven days</strong></td>
</tr>
<tr>
<td>Sum</td>
</tr>
<tr>
<td>Mean(kg/d)</td>
</tr>
<tr>
<td>SD</td>
</tr>
<tr>
<td>CV%</td>
</tr>
<tr>
<td>% by cat.</td>
</tr>
</tbody>
</table>
During the wet season there were varied differences in mean generation rates with the highest being infectious waste and the lowest chemical waste. The daily infectious waste generation over the seven days varies very slightly with a coefficient of variation of 18.16% as compared to the much fluctuating daily quantities of pathological waste with a coefficient of variation of 79.23%.

(ii) Dry Season Medical Waste Generation

Table 2.0: Quantities of medical waste generated during dry season

<table>
<thead>
<tr>
<th>Seven days</th>
<th>Infectious (kg)</th>
<th>Pathological (kg)</th>
<th>Sharps (kg)</th>
<th>Chemical (kg.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sum</td>
<td>7367.5</td>
<td>102.5</td>
<td>348.6</td>
<td>290</td>
</tr>
<tr>
<td>Mean (kgs/d)</td>
<td>1052.5</td>
<td>14.6</td>
<td>49.8</td>
<td>41.4</td>
</tr>
<tr>
<td>SD</td>
<td>129.57</td>
<td>14.57</td>
<td>15.99</td>
<td>-</td>
</tr>
<tr>
<td>CV</td>
<td>12.31</td>
<td>99.52</td>
<td>32.10</td>
<td>-</td>
</tr>
<tr>
<td>% by cat.</td>
<td>9.8</td>
<td>1.3</td>
<td>4.3</td>
<td>3.6</td>
</tr>
</tbody>
</table>

During the dry season, there were varied differences in mean generation rates with the highest being infectious waste and the lowest, pathological waste. The daily generation of infectious waste however, does not vary in quantities greatly as the coefficient of variation is 12.31% (Table 2.0). Pathological waste daily generation fluctuates greatly with a coefficient of variation of 99.52%.

The comparison test based on the coefficient of variation derived from the data for the wet and dry season on infectious, pathological and sharps waste generation reveal that there is no significant difference in generation between the two seasons as follows.

- Infectious waste, \( p=0.9436 \) (Not significant)
- Pathological waste, \( p=0.1564 \) (Not significant)
- Sharps, \( p=0.0507 \) (Not significant)

The seasonal variations for wet and dry season in hazardous health-care waste generation rates remained nearly the same during the two seasons. The fixed trend in the three hazardous waste generation rate during the wet and dry season could be due to lack of patients influenced greatly by climatic conditions like rainfall (Katoch and Vineet, 2011). The materials consumption during health services delivery are almost the same. Therefore, it could be easy to plan the quantities of materials required for waste reduction

b) Moi Teaching and Referral Hospital

(i) Wet Season Medical Waste Generation

The following are the summaries of the weighed health-care waste during the seven days of the wet season

Table 3.0: Quantities of medical waste generated during wet season

<table>
<thead>
<tr>
<th>Seven days</th>
<th>Infectious (kg)</th>
<th>Pathological (kg)</th>
<th>Sharps (kg)</th>
<th>Chemical (kg.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sum</td>
<td>2889.4</td>
<td>256.0</td>
<td>209.8</td>
<td>139</td>
</tr>
<tr>
<td>Mean (kgs/d)</td>
<td>412.8</td>
<td>36.6</td>
<td>29.9</td>
<td>19.9</td>
</tr>
<tr>
<td>SD</td>
<td>50.8</td>
<td>4.3</td>
<td>5.9</td>
<td>-</td>
</tr>
<tr>
<td>CV</td>
<td>12.31</td>
<td>11.65</td>
<td>19.97</td>
<td>-</td>
</tr>
<tr>
<td>% by cat.</td>
<td>82.7</td>
<td>7.3</td>
<td>6.0</td>
<td>3.9</td>
</tr>
</tbody>
</table>

During the wet season, there were varied differences in mean generation rates with the highest being infectious waste and the lowest, chemical waste. From Table 3.0, the coefficient of variation for infectious, pathological and sharps waste indicate a close relationship in quantities of the respective waste categories generated daily for the seven days during the wet season.

(ii) Dry Season Medical Waste Generation

Table 4.0: Quantities of medical waste generated during dry season

<table>
<thead>
<tr>
<th>Seven days</th>
<th>Infectious (kg)</th>
<th>Pathological (kg)</th>
<th>Sharps (kg)</th>
<th>Chemical (kg.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sum</td>
<td>5740.8</td>
<td>456.5</td>
<td>408.1</td>
<td>125</td>
</tr>
<tr>
<td>Mean (kgs/d)</td>
<td>820.1</td>
<td>65.2</td>
<td>58.3</td>
<td>15.9</td>
</tr>
<tr>
<td>SD</td>
<td>99.5</td>
<td>40.1</td>
<td>17.5</td>
<td>-</td>
</tr>
<tr>
<td>CV</td>
<td>12.13</td>
<td>61.48</td>
<td>30.04</td>
<td>-</td>
</tr>
<tr>
<td>% by cat.</td>
<td>85.3</td>
<td>6.8</td>
<td>6.1</td>
<td>1.9</td>
</tr>
</tbody>
</table>

During the dry season, there were varied differences in mean generation rates with the highest being infectious waste and the lowest, chemical waste. The daily pathological waste generation over seven days had varied quantities as confirmed by a coefficient of variation of 61.48%.

The comparison for wet and dry season coefficient of variation for infectious, pathological and sharps waste revealed the following:-

- Infectious waste, \( p=0.8521 \) (Not significant)
- Pathological waste, \( p=0.000 \) (Significant)
- Sharps waste, \( p=0.042 \) (significant)

The comparisons for the coefficient of variation between wet and dry seasons at Moi Teaching and Referral hospital for infectious, and sharps waste shows that there was no significant difference. This implies that the health-care materials demand and consumption during the wet and dry seasons was almost the same. There was however, significant difference in generation of pathological waste and sharps during the wet and dry season. It implies that there was varied consumption of healthcare materials during the wet and dry season. Budgetary
arrangements and healthcare materials procurement will also vary with seasons.

(iv) Summary Health-Care Waste Generation Rates
The following are medical waste generation rates for the two institutions:

(i) Hazardous health-care waste generation rates relationship for wet and dry seasons
At Kenyatta Teaching and Referral hospital, there was no significant difference in generation rates for the various hazardous waste categories as revealed by the values for the coefficient of variations. The hospital is situated at the capital city of the country and has served as a referral institution for more than 50 years. As a referral hospital for the long period, it has attained financial stability more than Moi Teaching and Referral hospital to sustain the health care services. The patient’s population is affected by seasonal changes. Hazardous health-care waste generation rates for the waste categories analysed do not change with seasons.

At Moi Teaching and Referral hospital, except for infectious waste category, there was significant difference in quantities of pathological and sharps waste categories. This institution was recently established as Teaching and Referral Hospital, serving the western region. It is yet to achieve a stable service delivery capacity to sustain high level medical materials supply and a constant patient’s referral system. The fluctuating medical supplies would therefore produce the evident pattern of medical waste generation. Health seeking behavior could be influenced by adverse weather conditions. This could create a significant difference in health-care waste generation rates between the wet and dry season.

The four hazardous health-care waste categories form the largest proportions generated daily in the two institutions. The generation rate based on bed capacity for each of the two institutions during the wet and dry seasons was 0.61 kg/bed/day at KNH (1800 beds) and 1.03 kg/bed/day at MTRH (712 beds). The rates however, were affected by the hospitals bed-occupancy rate. At KNH, the bed-occupancy rate was 300% (KNH, 2011) while that of MTRH was 99%. An evaluation study in Taiwan shows that the amount of health-care waste generated is directly associated with the number of bed occupancy. (Chang et al. 2009).

Further research shows that lower income countries have lower health-care waste generation rates than high income countries (WHO, 2006) and Chaurel et al. (2008). Generation of hospital waste differed not only across different countries but also within the same country by type of establishment (Jahandideh et al. 2009 and Patwary et al. 2009). The commentators further observed that the other factors that influence variations in generation rates include re-imbursements by National Health Insurance, capacity of the hospital, type of specialization, bed occupancy, number of beds for infectious diseases, outpatients per day and proportion of re-usable items. These factors also contribute to the difference in generation rates for the two hospitals.

The health-care waste generation rate of 0.61 kg/bed/day compares well with several studies from developing countries such as (Longe and William, 2006); (Longe and William, 2006); (Tai-Khatib et al., 2009); (Abdalla et al., 2008); (WHO, 2006); (Nemathaga et al., 2008); (Bendjoudi et al., 2009); (Taghipour and Mosafari, 2009); (Patwary et al., 2009) and (Abdalla et al., 2008).

AERD (2009) observes that in Kenya, the amount of infectious waste generated in healthcare facilities was 1:1 or higher than the general waste. This proportion for the two institutions almost confirms the computed values. It is an indication that the two institutions have not perfected their health-care waste segregation. The most affected category is infectious waste collection and disposal. The definition of infectious waste varies widely from country to country and that ambiguity of the waste category could lead to improper segregation of the waste that forms 25% of the hazardous category (Chaurel et al. 2008).

CONCLUSION AND RECOMMENDATIONS
Conclusion
The following conclusions and recommendations are derived from the findings of the study. Considering the four categories of health-care waste studied, (infectious, pathological, sharps and chemical waste), KNH generated 0.61 kg/bed/day and MTRH, 1.03 kg/bed/day. KNH generated infectious waste to general waste in the ratio of 0.7:1 and MTRH 0.6:1. Segregation of health-care waste in the two institutions was not done satisfactorily. The study found that there was no accounting of used chemicals as waste after use in the two institutions.

Recommendations
- The two institutions should do a regular weighing of the segregated waste categories and maintain records to monitor progress in generation rates. This would provide accurate data for planning health care waste minimization schemes and hence promote public health in the hospitals.
- Further analytical research should be done to determine the extent of the problem in the other hospitals in Kenya.
ACKNOWLEDGEMENT
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