Original Research Article

Management of biomedical waste in the South of the DR Congo: Current situation

Abstract

Effective management of biomedical waste is mandatory for healthy human beings and ~~for~~ a safe environment. Poor management of biomedical waste is a community health problem. This article reviews the methods of biomedical waste management. The management of biomedical waste is a ~~major~~ significantchallenge in the south of ~~the~~ DR Congo in terms of the implementation of the types of bins, the concentration of bleach used and the method of waste disposal. Staff training and awareness of waste management waste is of great interest ~~not only to the community but also to~~to the community and the associated employees.

Keywords: Waste, Biomedical, ~~Status~~, South~~,~~ DR Congo

Introduction

During the process of delivering healthcare, healthcare facilities (HCFs) can generate waste and by-products [1]. Medical solid waste is considered disposed waste generated by ~~activities such as~~ health protection, diagnosis, treatment, dental and scientific research. [1][2][3]. Proper disposal of healthcare waste has become a global concern due to ~~its~~ public health risks. [4]Mismanagement of healthcare waste is a problem, especially in most developing countries[5]. In most African countries, ~~health care~~healthcare waste management ~~is poorly~~needs to be better monitored or even neglected[6-11]. Thus, ~~the purpose of this study was~~this study aimed to assess the practice of HCWM and potential challenges in the southern provinces of DR Congo.

Method

This is a cross-sectional study carried out in public and private medical structures in the southern provinces (Upper Katanga, Upper Lomami, Lualaba, and Tanganyika) of the Democratic Republic, a country in Central Africa. A total of 14 structures were visited. Sheets were received and ~~analyzed~~ analysedusing Epi info 7.3 and Microsoft Office Excel 2013, and the results are presented in pie chart and histogram form.

Results and discussion

~~We gathered~~A a total of 6,228 responses were gathered from different medical structures, and the analysis is provided in the following paragraphs. ~~gave us the following results~~:

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Comment [SM2]: The abstract should cover the background, methodologies, findings and discussion of the study - which is lacking in this section. Suggest to review

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Comment [SM3]: The method of research needs further elaboration. Are there interviews conducted, or distribution of questionnaires

Comment [SM4]: Explain why the use pie chart and histogram is useful in presenting the result

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~~From Figure 1, we observe~~Figure 1 shows that 49.9% of structures visited were Health Centers, 28.3% were polyclinics, 12.6% were General Reference Hospitals, and 9.1% were Reference Health Centers. In addition~~And~~ 59.37% of staff had already undergone at least one biosafety training.

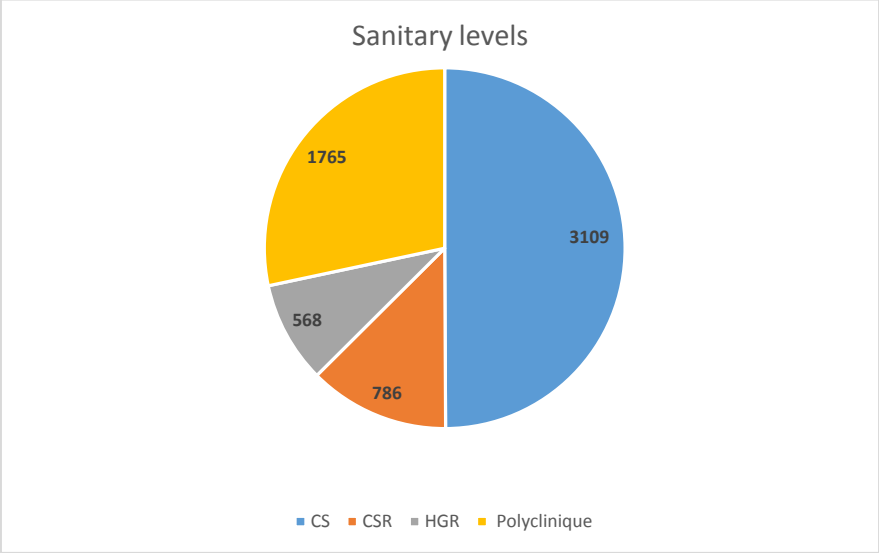

Fig. 1: Sanitary level of structures and training in biosafety

The observation thus made shows an increased number of first-line structures, an observation also made by Chenge et al. [12], in Kisangani in the Democratic Republic of Congo and likewise Samuel Bosongo et Al.[13] affirms, the services of doctors on the front line constitute a de facto situation, unplanned and unsupported, which is ~~largely due~~mainly due to the need for the professional integration of doctors because ~~in fact,~~ this phenomenon does not correspond to health policy since front-line service is delegated to nurse practitioners [14].

Table 1: Type of bins used

trash cans	Presence	Absence	Presence of sachets	Containing bleach
Unsullied objects	5,108	1,220	4302	
Tainted objects	4,986	1,342	4220	
~~**sharp**~~ **Sharp objects**	4,610	1,718		4,165

From this tableAs displayed in Table 1, one can ~~we~~ see that the use of trash cans according to the principle of waste sorting was not yet perfectly implemented in the medical structures visited. The presence of all types of trash cans was estimated at 4610, which is the small value which provides information on the presence of trash cans, i.e.,74.0%. Thus, 26% of our

Comment [SM5]: Please recheck the Figure 1. The earlier paragraph mentioned about . The use of pie chart is not accurate because it also showed result of percentage of employees attended the training.

Suggestion - Provide two different pie charts, and the legend should be percentage, thus consistent with the earlier paragraph.

The use of acronym for CS, CSR, HGR - suggest to highlight the acronym meaning.

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Comment [SM6]: Show the percentage in Table 1 as well

structures did not include all types of trash cans. Also, the ~~presence of~~ collection bags in the bins for soiled and unsoiled objects was present in 67.75% of all bins and only 66.87% of the bins for sharp objects contained bleach.

In any case, an effort is still to be made so that 26% of structures that do not bring together all types of trash can respect the sorting of hospital waste, which is an operation that is essential to guarantee the safety of medical staff, patients~~.~~ ~~,~~,, the entire elimination chain and ~~to guarantee~~guaranteeing public health in general. because Health professionals are required to sort hospital waste by separating biological materials from contaminated medical equipment~~,and~~ distinguishing hazardous waste from non-hazardous waste. Thus, each type of waste must be deposited in a specific bin, the capacity and shape ~~of which are~~ adapted to the particularities of each waste (sharp, liquid, soft, bulky, etc.).[15]

And BMW's basic management principle is Reduce, Reuse and Recycle – the 3Rs.Moreover, ~~the separation of~~separating the different types of waste generated, contributes to reducing the risks resulting from poor management by BMW. When waste is ~~simply~~ disposed of, there is an increased risk of mixing waste such as sharps and general waste. Because if they are not ~~properly~~ adequatelyseparated, syringes and needles discarded in hospitals ~~are very likely to~~will likely be reused.[16]

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Thus, waste must be sorted into containers at the source of its production, and according to Annex 1, the container used must be ~~labeled~~labelled. The annexes to the BMW (Management and Handling) Rules 1998, which initially numbered ten, have now been reduced to four.[17] This involves using bins of different colors for waste disposal. Color is an important indicator for the separation and identification of different categories of waste in appropriately colored containers. They should be properly ~~labeled~~ labelledaccording to where they were generated.[18][19].

Table 2 ~~t~~he concentration of bleach in the sharps bin

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Bleach % Concentration	**NOT**	**%**
0.05	647	**15.3**
0.50	1,366	**32.3**
1	1,023	**24.2**
10	1,184	**28.2**
Total	4220	**100**

Regarding the bleach used in sharps bins, the decreasing distribution in the percentage of concentrations used was ~~as follows:~~ 0.5%, 10%, 1% and 0.05%. However, the appropriate concentration of sodium hypochlorite required to disinfect general liquid biological waste is 5,000 ppm, or approximately 0.5%. For biological waste containing a high organic load (e.g., blood, proteins or lipids), the appropriate concentration of sodium hypochlorite is 10,000 ppm or 1%.[20] This disparity observed in Table 2 reveals the lack of formulation of phlebotomists who use bleach without knowing its composition and method of preparation. Healthcare facilities need an operational strategy to train stakeholders involved in ~~the production of~~producing medical waste to manage this critical problem. Because inappropriate employee

behavior and improper methods of medical waste disposal in hospitals can increase serious health risks and environmental pollution due to the contagious nature of the waste.[21]

Table 3: Waste disposal techniques used

Landfill: 2823 (45.32%) **Person trained: 1009: 35.74%**						**Incineration: 3405(54.67%)** **Person trained: 1181: 34.68%**		
Depth Well	**NOT**	**%**	**Blanket Waste**	**NOT**	**%**	**Incineration temperature**	**NOT**	**%**
2m	1326	46.9	**Nothing**	1665	**58.9**	**100**	2058	60.44
5m	1294	45.8	**active lime**	51	**1.8**	**500**	1340	39.35
10m	120	4.2	**Hydrated lime**	189	**6.7**	**1000**	5	0.14
> 10m	83	2.9	**Ash**	918	**32.5**	**> 1000**	2	0.07

Two waste disposal techniques were used: burial in 45.32% of cases and incineration in 54.67% ~~of cases~~. 35.74% of the staff of structures using ~~landfill~~ landfillsand 34.68% of those using incineration had already received training ~~in this regard~~.

For the burial, the depths of the wells were respectively distributed 46.9% for two meters deep, 45.8% for five meters, 4.2% for ten meters and 2.9% for more than 10 meters. Waste coverage at the end of the day was not done in 58.9%, 32.5% resorted to ashes, 6.7% to slaked lime and 1.8% to quicklime. As for incineration, 60.44% of the structures incinerated at a temperature around 100°C, 39.55% around 500°C, 0.14% around 1000° and 0.058% at more than 1000°C,

Most medical waste is incinerated~~,~~ a short-lived practice due to environmental considerations. The combustion of solid and regulated medical waste generated by health care creates many problems. Medical waste incinerators emit toxic air pollutants and ~~toxic ash residues which are the main~~ ash residues, which are the primarysource of dioxins in the environment. The International Agency for Research on Cancer, a branch of the WHO, has recognized the carcinogenic potential of dioxins and classified them as carcinogenic to humans.[2 2] This is indeed the case of our structures which ~~in the most~~ use makeshift incinerators using gasoline or fuel oil as fuel [23]. Good practice requires electric incineration which produces almost no smoke and at a temperature above 1000°C, one of the only technologies capable of correctly

treating all types of medical waste, and it has the advantage of significantly ~~reduce~~ reducingthe volume and weight of treated waste [24]. Indeed, incineration at low ~~temperature~~ temperatures(less than 800°C) or when plastic materials containing polyvinyl chloride (PVC) [25], constituting most of the bottles used in hospitals, ~~are~~ isincinerated, it forms hydrochloric acid (responsible for acid rain), dioxins, furans and various other toxic air pollutants. They are found in emissions ~~but also in~~and residual ash and fly ash (transported by the air and effluent gases leaving the incinerator chimney). Optimization of the process can reduce the formation of these substances if incineration only takes place at temperatures above 800°C [26]. Low-level, long-term exposure to dioxins and furans can cause damage to the immune system and developmental abnormalities of the nervous system, endocrine system and reproductive functions in humans. A high intensity and short exposure[27]

Comment [SM8]: Check back this statement.

As for the burial of waste, it was carried out for a long time in a precarious manner, without any constraint or control of the different categories of stored and buried waste. The consequences are ~~serious~~ severesoil and water pollution, and olfactory or visual nuisances. In our situation, it is appropriate to observe that most of the landfill pits are less than 5 meters, and the waste is not covered for the most part and those who can use it mainly use ash, which, unfortunately, suffers from a problem supply as is the case for lime.Ideally, the pit should be lined with low permeability materials, such as clay, to prevent pollution of shallow groundwater~~,~~ and fenced off so that waste pickers cannot access it. Medical care waste must be immediately buried under a layer of soil after each unloading[28]. For increased health protection (in the event of an epidemic, for example) or ~~for~~ the suppression of odors, it is suggested that lime be poured over the waste[29]. The pit should be sealed when filled.[30].

Note also the poor training of staff assigned to waste management, training estimated at around 35% only. ~~And yet~~Yet~~,~~ the most ~~important~~ essentialcriteria in the process of medical waste management in an environment are ~~respectively~~ qualified personnel, health facility infrastructure and waste control and the most efficient hospital is determined.[31] .

Although the quantification of waste is not yet practical in our hospitals, it should be clarified that the quantity and composition of medical waste may vary depending on the level of activity of the establishment generated, the type of installation, size, location, policies, waste management method, technology, waste regulations, infrastructure, as well as development levels of countries. [32][33]

Conclusion

Medical waste management must be considered not only in terms of environmental impact and potential long-term health effects, but also in ~~terms of~~ society's future energy needs. The highlight of BMW's management is that "the success of BMW's management depends on segregation at the point of generation". Thus, the proper identification, separation and disposal of biomedical waste is ~~an ethical and social responsibility of healthcare professionals~~healthcare professionals' ethical and social responsibility.

It should be mandatory for health facilities to train their health staff in accredited training centers, and this should not become just a one-time activity but rather a continuous process.

A more coordinated effort by pollution control authorities and better training of health workers and administrators are needed.

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