Policies and practices of biomedical waste management in different healthcare facilities in a developing country

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Abstract: Improperly managed biomedical wastes is harmful to both, the personnel dealing with it and the environmental health. In the present study five randomly selected healthcare facilities located in Himachal Pradesh, India were studied for cradle to grave evaluation of biomedical waste. The 872 bedded state medical college and hospital located at the capital city did not appropriately separate the waste especially at the point of generation. While in the regional hospital (210 beds), the colour-coding practices for waste segregation were not observed as per extant rules and guidelines. In the government run TB sanatorium (100 beds) the staff was not very well acquainted with the special categories of waste and its treatment henceforth. In the community and primary health centre, the waste received minimum attention by the producers and its handlers as either they were not aware of the practices or they did not have the resources to manage it.

Keywords: biomedical wastes; biomedical waste management; infectious waste; healthcare waste management; treatment; disposal; segregation; colour coding; collection; ART centre.


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1 Introduction

Medical waste is a very important environmental and health safety issue and its management is of great importance due to its potential environmental hazards and public health risks as if not properly handled and disposed of, it carry higher risks of infection and injury and may represent serious health hazards to health personnel and if not treated properly, maybe hazardous to both people and environment (Pruss et al., 1999; Mohee, 2005; Jang et al., 2006; Valavanidis et al., 2008; Zhu et al., 2008).

A legal and regulatory framework, which sets the standards to apply and, in particular, gives operative definitions including of different waste categories, is extremely important because the appropriateness of the biomedical waste management can be evaluated only according to its compliance with regulation (Caniato et al., 2015). A fundamental prerequisite for the successful implementation of any medical waste management plan is the availability of sufficient and accurate information about the quantities and composition of the waste generated. It is important to measure and quantify the amount of medical waste generated in each unit of the hospital periodically to ascertain which unit or department generates the highest and lowest amount of wastes. This could have implications for resource allocation in managing medical waste. When taking into account the current condition of medical waste management, the characteristics of generated medical waste in the area, and the significant environmental problems associated with waste, it is necessary to implement a segregation program for the reduction of hazardous infectious waste (Abor, 2007; Taghipour and Mosaferi, 2009).

Most of the studies and data in the literature are for developed countries with strict regulation on handling and disposal of healthcare waste (HCW) where the workers involved are fully aware of the health hazards associated with the handling of medical waste and needle stick injuries. Thus it is very difficult to use this data to estimate associated risk of medical waste handling in the poorer parts of the developing world, particularly South East Asia that includes nations like India, Pakistan and Bangladesh. Most often these countries lack regulation, and the knowledge about associated health hazards of the personnel involved in handling the HCW are very poor. The personnel involved are either illiterate or without any basic knowledge and training in healthcare waste management (Mato and Kaseva, 1999; Da Silva et al., 2005; Sarkar et al., 2006; Rahman et al., 2008). Rahman et al. (2008) labelled the waste pickers in Bangladesh who normally salvage every possible item of value from the medical waste with bare hands and feet and thus exposing them to the serious health risks. Taru and Kuvarega (2005) also reported lack of waste segregation in Zimbabwe as people who bring the waste for incineration tear open the bins to scavenge for usable items and food.

This paper studies the quantities of waste generated in five different healthcare facilities located in the state of Himachal Pradesh of the republic of India and the practices undertaken by the authorities responsible for its management. Biomedical waste should be transported within the hospital by means of wheeled trolleys, containers or carts that are not used for any other purpose. The trolleys have to be cleaned daily (Rao et al., 2004). However, the bio-medical waste (management and handling) rules, 1998 of Government of India superseded by the bio-medical waste management rules, 2016, does not stipulate regulation regarding transportation of biomedical waste within the generation facility. Biomedical waste thus collected may be treated and disposed of in a number of different ways. Many facilities, while providing a better healthcare service to the community, pass the responsibilities for dealing with the
infectious waste to an outside contractor. For example in Japan, more than 90% of the facilities have outsourced their infectious waste treatment (Tanaka et al., 2004).

Treatment and disposal systems can be classified as following:

1. in-house treatment: it includes chemical disinfection, use of needle destroyers, shredding for mutilation, autoclaving for disinfection, deep burial, burning and incinerating in special pits

2. out-house treatments: it includes transporting the waste to a central treatment facility where the waste is generally incinerated and then ash is deposited in a secured landfill.

Adopting the off-site treatment system means that a larger quantity of waste needs a higher-capacity treatment facility and thereby concentrates the release of emissions to a single source and in many cases is more expensive than an onsite system (Chaerul et al., 2008).

Certain treatment options may effectively reduce the infectious hazards of HCW and prevent scavenging but, at the same time, give rise to other health and environmental hazards. Thus a number of factors are to be considered before choosing the suitable treatment for the biomedical waste according to the type of the healthcare facility.

2 Hospital field survey (materials and methods)

Visits to five different types of healthcare facilities were undertaken by the authors to conduct a field survey to assess the biomedical waste management and handling practices prevalent at various hierarchical levels of healthcare system in India. These healthcare facilities were randomly selected. The authors at first acquainted themselves with the policies and guidelines of biomedical waste management laid down the government and related authorities in the country and compared and assessed those with that prevalent in other parts of the world to find out the areas for improvement undertaking a comprehensive desktop literature study and then visited five different types of hospitals i.e.,

1. a state run medical college and hospital (MCH)
2. a regional level government hospital (RH)
3. a government T.B. sanatorium
4. a government community healthcare facility (CHC)
5. a government primary healthcare facility (PHC).

The whole life cycle of biomedical waste since the time to its generation, segregation, storage, transportation, treatment and disposal was closely and carefully observed and informal interviews and discussions with the authorities responsible for its management were undertaken.
Policies and practices of biomedical waste management

Table 1  Hospitals studied and their basic statistics for the year 2013

<table>
<thead>
<tr>
<th>Hospitals</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Geographical classification</td>
<td>Urban</td>
<td>Urban</td>
<td>Urban</td>
<td>Rural</td>
<td>Rural</td>
</tr>
<tr>
<td>Bed strength</td>
<td>11,763</td>
<td>210</td>
<td>100</td>
<td>23</td>
<td>Nil</td>
</tr>
<tr>
<td>OPD/day</td>
<td>1,296</td>
<td>775</td>
<td>46</td>
<td>159</td>
<td>21</td>
</tr>
<tr>
<td>Occupancy (%)</td>
<td>84</td>
<td>86</td>
<td>25</td>
<td>74.29</td>
<td>Nil</td>
</tr>
<tr>
<td>Specialised departments</td>
<td>33</td>
<td>14</td>
<td>1</td>
<td>Nil</td>
<td>Nil</td>
</tr>
<tr>
<td>Total waste/day (kg/day)</td>
<td>76.234</td>
<td>26.339</td>
<td>1.742</td>
<td>2.635</td>
<td>------</td>
</tr>
</tbody>
</table>

Notes: Hospitals: 1: MCH; 2: RH; 3: TB sanatorium; 4: CHC; 5: PHC. Hospital 5 studied did not maintain biomedical waste record.

The following relation is being used by for calculating the percent bed occupancy:

\[ PBO = \frac{100 \cdot X \cdot Y \cdot Z}{X \cdot Y \cdot Z} \]

where \( PBO \) – percentage bed occupancy, \( X \) – total number of inpatients/inpatients service days for a period, \( Y \) – total number of inpatient bed count or bed strength, \( Z \) – number of days in the period.

3  Findings (observations)

3.1  Medical college and hospital

The MCH (872 beds) located at Shimla, around 370 km from the country’s capital city of New Delhi, had poor waste segregation practices as biomedical waste was found stored in municipal waste dumper and mixed waste was received from various departments of the hospital; neither the colour-coding practice was observed properly as per the rules and guidelines laid down by the government and related authorities nor do the hospital had its own written waste management policy. About 200–300 blood collection tubes were found in the municipal waste dumper alongside non-infectious waste that was further supposed to be disposed off with the other household wastes of the city at the municipal corporation’s waste management site.

Highest waste generation per day was observed in this healthcare facility since it was the biggest amongst studied and is a super specialty facility. Thus, patients from far and wide and far flung places visit this facility for their treatment and also since it is a research facility too, patients are referred here from other smaller hospitals from the state for their specialised treatment.

Uncovered metal carts and wheeled plastic bins were being used for the transportation of the waste from various departments and wards of the hospitals to the storage unit. The personnel handling and transporting the waste used only surgical gloves and sometimes facemasks as protective clothing. The waste storage unit (Figure 1) at the hospital was located outside the hospital and was covered, locked and well ventilated. However, the
waste bags were kept on the ground till the time a vehicle specified for the purpose of the collection of the biomedical waste collected it and transported it to a waste treatment facility located 30 km away.

**Figure 1** (a) Waste storage unit at MCH (b) Waste bags stored before transportation (see online version for colours)

![Figure 1](image)

**Table 2** Treatment and disposal of various categories of waste at hospital 1 (MCH)

<table>
<thead>
<tr>
<th>Type of bag</th>
<th>Treatment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yellow</td>
<td>Outsourced for incineration</td>
</tr>
<tr>
<td>Red</td>
<td>Autoclaved and shredded at the hospital</td>
</tr>
<tr>
<td></td>
<td>Recycled by local vendor</td>
</tr>
<tr>
<td>Blue/white</td>
<td>Disinfected with 1% bleaching solution</td>
</tr>
<tr>
<td></td>
<td>Burial pit at the hospital</td>
</tr>
<tr>
<td>Black</td>
<td>Municipal waste</td>
</tr>
</tbody>
</table>

*Source: MoEF and GoI (2011)*

### 3.2 Regional hospital

The regional hospital studied was located at Hamirpur, Himachal Pradesh, 500 km away from the national capital region. It had a bed strength of 210 beds with 14 departments that includes a special anti retroviral therapy (ART) centre. Due to highly infectious nature of the waste generated in such centres it should be segregated properly, handled and treated with proper care and by trained personnel only but on investigations it was found out that it received the same treatment like the rest of the waste generated from other wards and departments of the hospital.

The staff handling the waste were not properly educated and trained with almost no protective gear and clothing except for surgical gloves that were inappropriate in case of needle stick injuries and injuries by sharps and glass [Figure 2(a)]. The colour-coding practice was also poorly observed here and no special carts etc were being provided by the administration to carry and transport the waste within the hospital premises thus putting at risk not even the handlers but also other patients and persons accompanying them.
The waste thus collected was stored in a special unit situated near to hospital parking so that its transportation became easier. It was a newly built room and the floor was tiled for easy cleaning but the ventilation was poor as it was covered from all sides and the door was kept locked. However due to the staff’s ignorance the waste collected in this room was also kept haphazardly with all bags mixed and kept together [Figure 2(b)].

The waste was then transported to a waste treatment facility that was located at Pathankot, Punjab at a distance of about 180 km from the healthcare facility for its final treatment and disposal.

3.3 TB Sanatorium

Sanatorium is a medical facility for long-term illness, most typically associated with the treatment of tuberculosis. This TB Sanatorium is one of the oldest in the entire region and patients from neighbouring countries also come here for the treatment of TB as the climatic conditions here are suitable for TB patients.

This facility had bed strength of 100 beds with average daily bed occupancy of 19 in 2011, 16 in 2012 and 25 in 2013.

<table>
<thead>
<tr>
<th>Type</th>
<th>New</th>
<th>Discharged/old</th>
<th>Daily average</th>
</tr>
</thead>
<tbody>
<tr>
<td>Indoor patients</td>
<td>232</td>
<td>188</td>
<td>25</td>
</tr>
<tr>
<td>Outdoor patients</td>
<td>1,0975</td>
<td>2,371</td>
<td>46</td>
</tr>
</tbody>
</table>

The average daily biomedical waste generated was less than 2 g/day (1.742 g/day for 2011 to 2013) which mainly consisted of needles and syringes, scalpel blades, glass vials of tuberculin, stylet, capillary tubes, ampoules, test tubes, pipette slides, cover slips, lancets, broken glasses, sputum cup, sputum, vacuum tubes, thoracic tubes and dust respirators.

The waste generated in this facility was primarily disinfected at the facility itself by either using bleaching powder or 5% phenol and the needles and sharps were either burnt first or destroyed using a needle destroyer and then were transported outside the facility for further treatment and disposal at an expenditure of INR 51993 in the year 2011, INR 53443 in 2012 and INR 52810 in 2013. Since the waste generated was a few grams per day (Table 4), it was not collected on daily or regular basis. Also neither there was a burial pit, nor any other onsite treatment or disposal provision. There was no special
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waste storage unit within the hospital premises. The waste was thus collected from the bins after several days (sometimes up to a week) and the personal responsible for waste management and handling here were the sweepers, who use to collect it and send it for final disposal.

Table 4  Average waste generated at the hospital 3 (TB sanatorium)

<table>
<thead>
<tr>
<th>Year</th>
<th>Category 3 red microbiological waste (g/day)</th>
<th>Category 4 blue needles and sharps (g/day)</th>
<th>Category 7 red solid waste (g/day)</th>
<th>Category 8 yellow soiled waste (g/day)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2011</td>
<td>Nil</td>
<td>2.681</td>
<td>0.462</td>
<td>0.451</td>
</tr>
<tr>
<td>2012</td>
<td>0.005</td>
<td>0.175</td>
<td>0.395</td>
<td>0.237</td>
</tr>
<tr>
<td>2013</td>
<td>0.036</td>
<td>0.219</td>
<td>0.422</td>
<td>0.143</td>
</tr>
</tbody>
</table>

3.4 Community health centre

The CHC or the community health centre selected for the study was randomly selected out of a total of 5,187 in this South East Asian nation. Over a hundred patients frequented this hospital everyday (Table 5) and therefore, the amount of waste generated was also significant (Table 6) and needed to be addressed properly.

Table 5  Average statistics for hospital 4 (CHC)

<table>
<thead>
<tr>
<th></th>
<th>2011</th>
<th>2012</th>
<th>2013</th>
</tr>
</thead>
<tbody>
<tr>
<td>OPD/day</td>
<td>128</td>
<td>134</td>
<td>159</td>
</tr>
<tr>
<td>IPD/day</td>
<td>20</td>
<td>18</td>
<td>18</td>
</tr>
<tr>
<td>Occupancy (%)</td>
<td>83.93</td>
<td>77.80</td>
<td>74.29</td>
</tr>
</tbody>
</table>

Table 6  Average waste generated for hospital 4 (CHC)

<table>
<thead>
<tr>
<th>Year</th>
<th>Category 1 (kg/day)</th>
<th>Category 4 (kg/day)</th>
<th>Category 6 (kg/day)</th>
<th>Category 7 (kg/day)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2011</td>
<td>4.21</td>
<td>4.12</td>
<td>19.96</td>
<td>76.84</td>
</tr>
<tr>
<td>2012</td>
<td>7.13</td>
<td>7.09</td>
<td>43.70</td>
<td>37.23</td>
</tr>
<tr>
<td>2013</td>
<td>7.50</td>
<td>10.56</td>
<td>36.93</td>
<td>32.66</td>
</tr>
</tbody>
</table>

The biomedical waste was neither segregated nor colour-coded. The waste collected from various rooms was openly burnt in backyard of the hospital. There was no specific area marked for the storage of the waste. The person responsible for handling the waste in this hospital was the sweeper and was without any formal training. The logbook was also poorly maintained.

The practice of burning waste in the open, leads to environmental and health hazards. This process became ineffective during the rainy season and it also lead to scavenging by rag pickers, stray dogs and monkeys and had become a local nuisance.
3.5 Primary health centre

Primary health centre (PHC) is the basic structural and functional unit of the public health services in developing countries. The PHC selected for the study was randomly selected out of a total of 24,448 in the country.

The PHC selected was located in the rural area like most of the PHCs in the country. Unfortunately, the condition of the waste management was the worst of all.

The total number of patients treated here in the year 2013 was 7599. It does not have any beds and thus no in-patient department (IPD).

The PHC was recently shifted to a new premise but the building did not have a pit for burial or any other provision for incinerating the biomedical waste. Neither did the officer in charge have any budget for the construction of the same. Therefore, they were dumping their waste along with the municipal waste stream.

No biomedical waste record book or logbook was being maintained by the hospital staff. The waste was not collected in colour coded bags or treated or disposed off category wise as they did not segregate the waste neither at the point of generation nor anywhere else in the whole procedure.

Though the staffs claims that they used to burn or incinerate the hospital waste that comprised of expired medicines, bandages and other general waste in the previous premises, now they just dump it along with the general waste.

The Officer in Charge showed willingness to construct the burial pit or a ground pit for burning the waste but demanded the budget for the same.

4 Discussion

The state of the biomedical waste management at all levels of the hospitals studied in this paper was dismal. There was no proper management of the waste. Though an effort was being made at the larger hospitals such as MCH and RH (bed strength over 100) to segregate the waste at the point of generation in colour coded bags and containers, it was not being efficiently done either due to lack of proper knowledge or due to lack of time and already overburdened job.

Though it was commendable that larger hospitals (MCH and RH) had a waste storage unit within the premises in accordance to the guidelines, it was still an environmental health risk and an occupational hazard since the waste was collected, stored and transported by non-specialised and untrained staff.

The smaller hospitals on the other hand (CHC and PHC) lacked manpower, resources and the funding to manage the biomedical waste due to which it was neglected and dumped either with the general waste or was burnt openly. The hospital administrators and officer in-charge however, showed willingness to install setups to manage the waste effectively.

The regulation for biomedical waste management therefore needs to be strictly adhered to in developing countries. Biomedical waste needs to be segregated into containers/bags at the point of generation in colour coding schedule prior to its storage, transportation, treatment and disposal. All the containers must be labelled with ‘biohazard symbol’ or ‘cytotoxic hazard symbol’ as applicable. The label shall be non-washable and prominently visible; colour-coding of waste categories with multiple treatment options to be selected depending on treatment option chosen. Red colour coded
bags marked with biohazard symbol are universally used for the segregation of risky or infectious waste.

Proper protective gear including eye protection, face mask, gloves, overalls or protective gowns, shoes and disinfectants to all those handling the waste and coming in its direct contact should be provided. Covered carts should be employed to transport the waste within the hospital premises and it should not be done manually to reduce the occupational hazard.

Larger hospitals where the bed strength is above 100 beds and average biomedical waste generated is above 25 kg/day, an in house facility such as a shredder and an autoclave should be installed for the disinfection of the waste before its final disposal to reduce the risk of further infection and for recycling the plastic bottles, empty glucose bottles and such other waste. For other healthcare facilities where average waste generated is comparatively lesser, a deep burial pit within the hospital premises should be made in accordance to the prevailing biomedical waste management rules (biomedical waste management rules, 2016 in India) (MoEF&CC and GoI, 2016). But under no circumstance the biomedical waste must be dumped with the general waste or is left untreated.

5 Conclusions

The results of this study have shown that the effective biomedical waste management is not only the responsibility of the government but also the hospital administration. It is government’s job to make rules and laws to manage and handle biomedical waste but then its hospital administration’s job to educate its workers and other employees to implement these rules to effectively manage this menace. Polluter pays principle is applicable here too, where larger hospitals (MCH, RH and Sanatorium) are spending money to outsource their biomedical waste for its effective treatment and disposal, smaller hospitals (CHC and PHC) are unable to manage it due to their economic and social constraints. Therefore, it is recommended that proper allocation of funds and manpower should be there in all types of hospitals irrespective of it being large or small. In developing countries, the main focus today is to provide healthcare facilities to their huge population but since prevention is better than cure, it is equally important to contain the spread of infectious diseases at the primary level by effective management of biomedical waste.

References


Policies and practices of biomedical waste management