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RESEARCH ARTICLE

Biomedical waste segregation and their management in urban area of Gorakhpur: A survey for long term approach

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ABSTRACT

Biomedical waste (BMW) generated from medical centers have become a serious health threat worldwide including India. Unsegregated and insensitive disposal of BMW can become a source of spreading serious diseases not only for hepatitis, tuberculosis, HIV but also the recent pandemic of COVID-19 among their handlers and society. Our investigation was carried out to assess the waste handling, their segregation, disposal and treatment system of hospital BMW in the various medical institutes' established in Gorakhpur city. The study was conducted in accordance with the questionnaire as per guidelines of "BMW Management Rules, 2016" amended in 2018. We have found that almost 27 Metric tons of BMW were generated monthly by seven hospitals; in which, medical centers with the name of BRDMC generated 164.7 followed by NSCBDH, GSGC, DWH, LCH, REH and MMNH produced 33.8, 29.9, 20.7, 10.3, 7.9 and 4.3 quintals of wastes, respectively. They also generated 20.74%, 35.78%, 9.8%, 32.3%, 12.7%, 41.3% and 28.6% per day hazardous wastes in the above sequence of hospitals in comparison to non-hazardous wastes. A yellow colour container waste (a potential source of infection) was higher among the hospitals of BRDMC, GSGC, DWH and MMNC; whereas red colour containers wastes (recyclable contaminated waste) was higher among NSCBDH, LCH and REH, respectively. Our surveyed hospitals produce approximately 10-40% of hazardous wastes daily. Proper guidelines of segregation and treatment are an essential component for reducing the risk of BMW generated infections. Continuous training and fixing the responsibility of medical staffs are the key criteria's for reducing the chance of contamination and per unit BMW generation.

***Key words*:** Hazardous; Biomedical waste; Infectious diseases; MPCC; Segregation; Municipal waste

1) INTRODUCTION

An Biomedical waste (BMW) means useless or unwanted materials discarded from hospitals and medical centers. It includes used needles or syringes, blood or blood products, resected body parts, processed diagnostic kits and samples, pharmaceuticals, medical consumables and radioactive materials used in health care activities [1]. Medical care is very essential part of community health, but improper management of their waste becomes hazardous for living life of the society. BMW has higher potential for infection and injury than any other of solid waste (1). BMW (Management and Handling) Rules, 2016 of India, says that "BMW is generated during the diagnosis, treatment or immunization of human beings or animals or in research activities affecting thereto or in the generation or testing of biological or in health camps" [2, 3]. As per suggested by World Health Organization (WHO), 15% to 35% of hospital waste is regulated as hazardous [4]. They directly and indirectly harm to human as well as all biological life of earth.

Gorakhpur is a major city of lowland (tarai) region in the northern India, situated in the bank of river Rapti, with a population of approximately 0.8 Million (census 2011) [5]. This area comes to high risk zone of infectious and vector borne diseases because of their low socioeconomic status and highly dense population [6]. So, urban area of Gorakhpur is a hub of medical facilities, not only for eastern part of Uttar Pradesh, but also the many districts of western Bihar as well as our neighbour country Nepal. Due to heavy load of patients, here government and private hospital generates a very large amount of wastes. They deposited BMW either the inside or outside of hospital grounds in the common containers for further transportation and disposal along with municipal solid waste. Open dumping habits of BMW become serious health hazards for rag pickers and handlers due to injuries from needles and other types of infectious material used in healthcare institutions [7]. Considering its impact on the environment and health, BMW management requires immediate academic attention by increasing the

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awareness during training courses. We must also focus on cost effective and eco-friendly methods for its disposal.
The objectives of this study were: (i) to quantify the total BMW production of hospitals and their segregation among different colour coded containers or boxes, (ii) to analysis the hazardous and non-hazardous wastes per day, and (iii) to assess the waste handling and treatment process and its mandatory compliance with regulatory notifications for BMW Management Rules, 2016, among seven hospitals of urban area of Gorakhpur city.

2) MATERIALS AND METHODS

Questionnaire development and data collection

This Study was conducted in accordance with questionnaire based proforma as per guidelines of "BMW Management Rules, 2016" amended in 2018 passed by the Ministry of Environment, Forest and Climate Change, Government of India [2, 8]. These rules are applied on all the medical professionals and handlers for improving the collection, segregation, processing, treatment and disposal of these BMW for environmentally sound management and their impact on the society. So, we have prepared the proforma for collection of data from various hospitals. The data was further analyzed and cross checked by telephonic conversations with hospital authorities and data providers.
We piloted this conservative study under the partial fulfillment of dissertation work of post graduate environmental science students from 15 Feb 2020 to 15 March 2020. We followed the systematic approach towards the problem of BMW in the urban area of Gorakhpur. Total seven hospitals have been visited by the researchers in which two were large multispecialty hospitals, two were district hospitals and three were nursing homes. Researchers have approached the staff of hospitals to get the actual observation of BMW practices and filled the proforma with their consent. We have also examined the various pollution control committee management system and their coordination for BMW at hospital level.

3) RESULTS AND DISCUSSION

The ***BMW production and their segregation***

We surveyed the seven hospitals and observed that they collect BMW on daily basis both degradable and non-degradable wastes. The hospital managements were aware for government regulation for BMW segregation and disposal. They also used regularly containers or bag with color coded (yellow, Red, blue, white [transparent] and black) system for collection of BMW as per their nature. Mostly medical staffs were trained for handling the BMW and using the personal protective equipment such as mask, gloves, apron etc.
The data was collected on the month of February 2020 from the hospitals of Baba Raghav Das Medical College (BRDMC) and Netaji Subhash Chandra Bose District Hospital (NSCBDH). However, Guru Shri Gorakshnath Chikitsalay (GSGC), District Women Hospital (DWH), Life Care Hospital (LCH), Raj Eye Hospital (REH) and M.M. Nursing Home (MMNH) has provided their data for the month of January 2020 in our survey. We have found that 27.16 Metric tons (MT) BMW was generated on monthly basis by seven hospitals form all type of wastes; in which, BRDMC generated 164.7 quintals, 33.8 quintals in NSCBDH, 29.9 quintals in GSGC, 20.7 quintals in DWH, 10.3 quintal in LCH, 7.9 quintals in REH and 4.3 quintals in MMNH respectively for all type of wastes. The hospital's waste was also calculated by the average BMW generated per day among hazardous (collected in yellow, red, blue and white containers) and non-hazardous (collected in black containers or dump in any site of hospital campus and send to Nagar Nigam for disposal) wastes in our study. We have found that BRDMC generated (20.74%), NSCBDH (35.78%), GSGC (9.8%), DWH (32.3%), LCH (12.7%), REH (41.3%) and MMNH (28.6%) hazardous waste in comparison of non-hazardous wastes (**figure 1**).

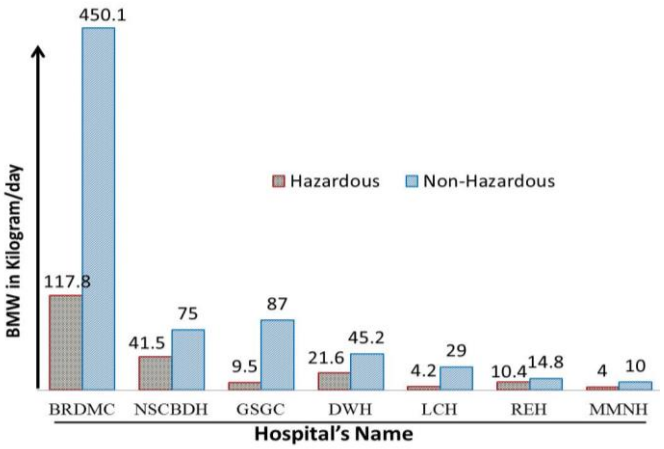

Figure1: Biomedical waste (BMW) in per day among hazardous (yellow, red, white and blue containers/boxes) and non-hazardous (black containers/boxes and hospital dumps for collection of Nagar Nigam) waste in different hospitals; **Abbreviations**: BRDMC: Baba Raghav Das Medical College, NSCBDH: Netaji Subhash Chandra Bose District Hospital, GSGC: Guru Shri Gorakshnath Chikitsalay, DWH: District Women Hospital, LCH: Life Care Hospital, REH: Raj Eye Hospital and MMNH: M.M. Nursing Home

Segregation of BMW as color coded system

Quantitative data of BMW among color coded containers or bags were also observed from all the hospitals (**table 1**). However, proper segregation of BMW as per recommended by BMW Management Rules, 2016 was lack. Yellow and red container wastes were very much segregated but white, blue and black containers wastes were intermixed in mostly hospitals. We found most suitable data from hospitals of NSCBDH and DWH as per recommended color coded system (see **table1**). Our survey find that yellow color containers wastes (potential source of infection) was higher among the hospitals of BRDMC, GSGC, DWH and MMNC; whereas, red color containers wastes (recyclable contaminated waste) was higher among NSCBDH, LCH and REH (**table1**). Among all the hospitals BRDMC produces highest quantity of black color coded containers/bins wastes.

Table 1: Color coded box wise biomedical waste in Kilogram per day (formula: waste in kilogram/day = color

coded box-wise waste per month/no. of days in given data month) approximately.

S. No.	Name of the Hospital	Yellow	Red	white	Blue	Black
1.	Baba Raghav Das Medical College (BRDMC)	65.62	52.14			450.1
2.	District Women Hospital (DWH)	12.1	5.0	0.5	4.06	45.2
3.	Netaji Subhash Chandra Bose District Hospital (NSCBDH)	16.5	18.5	0.3	6.2	75
4.	Guru Shri Gorakshnath Chikitsalay (GSGC)	5.02	4.47	-	87.1	
5.	Life Care Hospital (LCH)	2	3	0.2	30	
6.	Raj Eye Hospital (REH)	3.6	6.1	0.73		14.8
7.	M.M. Nursing Home (MMNH)	3.0	1.0	10		

BMW management and treatment methods

Five major hospitals send their hazardous BMW to Medical pollution control Committee (MPCC) and the remaining two hospitals REH and MMNH send their waste to Royal Pollution Control Committee (RPCC); whereas non-hazardous BMW collected by the Nagar Nigam, Gorakhpur at the hospital site. All the hospitals have claimed that they transported their waste with proper labeling and segregation through labeled boxes or containers to the central storage system. However, they directly discharge their waste water into the sewer system. All the hospitals take daily report on sanitation work without any site observation.

MPCC is the most common BMW treatment and disposal plant (a NGO) located at Khalilabad, Basti (U.P). They firstly segregate the collected BMW according to the norms at the plant site. They claim that proper segregation of BMW does not occur through hospital. They also recommend that infected urine, cough, O. T. clothes and microbiological wastes must be treated by 1% hypochloride solution for 30 minutes and then send to plant. Treatment of yellow container waste done by incineration and further smoke washing takes, remaining ash are in nature, so it is send to hazardous waste disposal plants and active carbon droplet separator some treatment plants for the water and air purification. They do autoclave and shredding of Red (plastics) and Blue (Glass) containers whereas white (metal) containers waste autoclave and remaining send to foundries especially Agra (U.P.) for recycling. Royal pollution control services (RPC) also follow the treatment methods recommended by the government authorities. The disposal of non-hazardous BMW with general waste is done near the dumping ground of Maheshra, Gorakhpur by municipal corporation.

Short comings in management of BMW

Medical facilities in urban area of Gorakhpur are improving faster than those in the rural areas due to central position of Purvanchal and rapid urbanization [9]. BMW management systems are already overburdened. Hence, an additional load due to mixing of hazardous BMW from hospitals magnifies the problems of this zone regarded as high risk area of infectious and vector borne diseases like hepatitis, malaria, dengue, HIV, Japanese encephalitis, including latest pandemic of COVID19 [6,10-11]. The shortcomings in the existing BMW management system are: (i) the segregation of BMW in almost all hospitals is not reasonably acceptable. (ii) Color-coding containers or bins for various categories of BMW is not followed especially some hospitals mixed the white container waste in red, while blue with black. (iii) The storage of BMW is not present in specific isolated area with lack of proper hygiene (**figure 2**). (iv) Personal protective equipment and accessories are not provided to all the health practiceners and workers, (v) Sometimes plastics or glasses are also incinerated leading to possible emission of harmful ashes and gases, (vi) Finally general awareness among the large proportion of hospital staff were completely unaware for proper management of BMW.

Figure 2: **(A)** Color coded containers for the collection of BMW in District hospital, Gorakhpur, **(B)** Disposal of sharp waste and polythene in same bin, **(C)** BMW mixed with garbage dump are going to dumping place of Nagar Nigam and **(D)** Intermixed hazardous and non-hazardous waste is same polythene, needed segregation.

4) DISCUSSION

BMW is a small fraction on municipal waste; in which infectious hospital waste represent only small fractions of total medical waste [12]. There should be a greater concern on how much of the waste produced is actually spreadable or hazardous. In our small survey of seven hospitals reveals 27 metric tons BMW monthly in Gorakhpur. This study was quite similar to the studies of Delhi, Agra and Dhaka city, Bangladesh [1,13-14]. In India, the range of hazardous waste could vary from 15% to 30% depending on the total corpus of waste produced [15-16]. However, in our study the hazardous waste was slightly

higher around 10-40%. According to the World Health Organization (WHO) approx. 85% of hospital waste are non-hazardous in nature, 10% consist of infectious waste, and around 5% are non-infectious but come in hazardous category [15,17]. If we see about 15% and 20% of medical wastes are regulated as potentially hazardous in U.S.A and Pakistan; respectively [15,18]**.** But hazardous waste is slightly higher in our country. So, we have to need the proper planning for reducing the amount of hazardous/infectious waste.

We have also observed that health-workers are frequently unsound and taking casually the segregation of BMW among color coded boxes. Sreegiri *et al*., Mathur *et al*. and Sood *et al*. also found that 44% of our sample populations were not aware about the management of BMW [19-21]. A more study done by Narang *et al*. seen that almost 89% participants were not aware about seriousness of intermixing of BMW with municipal waste [22]. These studies including our study show the relative negligence among health care workers regarding this issue.

Heavy load of population load and rapid urbanization has led to more government and private hospitals including various specialized clinics in our community. The generation of surplus amount of BMW comes with the frequent growing health care facilities. Most of the hospitals do not have proper waste treatment and disposal facilities. In the cities where common treatment facilities have come up, many medical establishments are yet to join the common facility. However, the more serious situation in future may arise due to the toxicity and unavailability of dumping grounds for such wastes. The results of the our study demonstrate the need for strict enforcement of legal provisions and a better environmental management system for the disposal of BMW in the studied hospitals, as well as other healthcare establishments in urban area of Gorakhpur.

Long term planning for future prospective

The impact of BMW on our environment is very life threating and harmful for our ecosystem [23]. As we see the impact of infectious diseases in our society and day-by-day the increasing load of medical facilities in Gorakhpur, it must be needed an extremely important task for BMW. The identification, segregation and disposal of BMW are a social and ethical responsibility of our health care workers [24-25]. Proper separation of hazardous and non-hazardous must be done very carefully. The major BMW treatment plant is so far; distance between MPCC, Khalilabad and Gorakhpur is approx. 32 Km, so a big treatment plant is needed in Gorakhpur. However, we must secure that disposal of BMW by deep burial is permitted only in rural or remote areas with prior approval from the Central Pollution Control Board and as per the Standards specified BMW management rules, 2016 amended in 2018.

It should be made compulsory for healthcare facilities to get their healthcare personnel trained from accredited training centers and it should not become merely a one-time activity but must be a continuous process. The application of proper waste management techniques and its identification in the curriculum helps to improve their understanding of good practice in BMW management. We also need a cost effective and environment friendly technology. A more coordinated effort from the pollution control authorities and better training of health care workers and administrators is required.

5) CONCLUSION

Our surveyed hospitals produce approximately 10-40% of hazardous wastes daily. Lack of all the color coded containers segregation and management of BMW increases the risk of communicable diseases. Awareness of proper disposal and treatment is essential component for reducing the risk of BMW based infections. Continuous training and fixing the responsibility of medical staffs are the key criteria's for reduction the chance of infectious contamination and per unit BMW generation. Finally, strict implementation of "BMW management rules, 2016, amended in 2018" is the need of the hour.

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