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Factual Status of Bio-Medical Waste Management in Kota, Rajasthan, India

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Abstract: ***Hospitals including all types of health care centers generate a lot of wastes per day which needs to be segregated, collected and transported to the treatment and disposal site according to the norms prescribed by the Central Pollution Control Board (CPCB), India. After reading about mismanagement of bio-medical waste in local newspapers of Kota city, it was planned to perform an analytical study to find out the factual status. During study, the hospitals of Kota both government and private were visited and the status of bio-medical waste management was studied right from its generation to the final transportation from the hospitals by concerned agency nominated for this purpose. It was noticed that treatment and disposal facilities are not available at Kota and as per official records; the waste is transported to another city Alwar. During the study period, this fact could not be verified as there were no vehicles seen transporting bio-medical waste daily from Kota to Alwar and no monitoring system was seen in place for this purpose whether the operator has actually transported the waste to the treatment site or dumped it somewhere else with municipal solid waste. Other than this, many shortcomings in the system were also noticed during the study period. The segregation is not performed at the point of generation, the employees deployed for segregation, collection and transportation are neither sufficient in number nor well trained and do not have any safety equipment, transportation is not carried out properly and most critical point to note is that the city does not have any treatment plant of its own. There is a lack of awareness among all stakeholders regarding new Bio-Medical Waste Management (BMWM) Rules, 2016. The concerned authorities need to take an immediate action for proper management of bio-medical waste in Kota; otherwise it may create severe health hazards to human health, especially the young students studying in coaching institutes of Kota.***

Keywords: Bio-medical waste, Generation, Incineration, Segregation, Treatment and disposal

I. INTRODUCTION

India has more than 15000 hospitals, clinics and health care centers generating a large quantity of bio-medical waste daily. Bio-medical waste is a type of hazardous waste and being infectious in nature requires special management processes to handle it.

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Infectivity and toxicity are two important characteristics of bio-medical waste and hence needs to be given utmost care. If left unattended, bio-medical waste may create hazard to the human health and environment. Bio-medical waste generates in hospitals and clinics during processes of diagnosis, immunization and treatment. It incorporates waste , for example, human tissues or body parts, sharps and other irresistible materials.

Bio-medical waste is classified into two categories based on its characteristics, source of generation and the level of hazard to the environment. About 75% to 90% of the bio-medical waste is under non-hazardous category whose characteristics are similar to municipal waste and hence non-risky in nature whereas remaining 10% to 25% of the bio-medical waste falls under hazardous category having infectious and toxicity characteristics.

A. Study Area

Kota once in the past known as Kotah, is the 25th biggest district in the northern Indian territory of Rajasthan. It is located 240 kilometers south of the state capital, Jaipur. It is situated on the banks of the Chambal River.

Kota is famous for coaching institutes preparing students for pre-engineering and pre-medical entrance examinations. These days, it is better known as "Education City of India". More than 1.5 Lakh students from India come to Kota to prepare for different entrance exams and it has helped a great deal of students in progressing towards their profession. According to 2011 Census of India, Kota had a population of about 1 million. Because of huge number of students, Kota requires well established medical services and safe environment.

B. Aim of Study

Bio-medical waste is known to create havoc if it is not managed properly. It may prove to be dangerous for the human health and environment as a whole, if it is either mixed with municipal solid waste or disposed off without adopting proper treatment processes.

After reading some adverse news about mismanagement of bio-medical waste in Kota city, it was planned to perform out an analytical research and find out the factual status of bio-medical waste management.

To carry out the research; it was decided to identify the sources of bio-medical waste i.e. generation, segregation (separation), collection, transportation, treatment and final disposal of waste in various government and private hospitals located in Kota city.

II. RELATED WORK

Many researchers have carried out their studies on management of bio-medical waste in India and abroad.

During a recent study in Chennai, India in 2018, it has been found that there is a lack of proper training regarding the bio-medical waste generated in health care centers and the study suggested for better management of bio-medical waste [1]. In a study of 2017, the loopholes in handling, segregation, and transportation were identified and concluded that negligence in the process of segregation, lack of regular training and inadequate allocation of funds and other resources are the main drawbacks [2]. Yet another research paper of 2016 describes bio-medical waste management practices and suggested that colour coding must be followed as per rules [3].

The need of the well established bio-medical waste management system has been justified in 2015 along with the recommendation of establishing separate special courts to handle the matters of pollution [4]. A research of 2013 concluded that bio-medical waste is one of the most dangerous wastes generated by human beings and it is becoming challenging issue in India and therefore proper methods of treatment needs to be developed for health and environmental safety [5]. During 2012, a study was carried out to understand the awareness amongst the employees for bio-medical waste management practices [6].

During a study carried out in 2009 at Chennai, India it was found that all the bio-medical waste from hospitals was disposed off with municipal solid waste and there was no adherence to the rules [7]. Another study took place in 2009 to comprehend the role of various stakeholders and review the management practices of bio-medical waste [8]. In an analogous study carried out in Lucknow, India in 2006, it was found that both type of hazardous and non-hazardous bio-medical wastes are dumped together within the hospital area and then mixed up with municipal solid waste. There were no separate bins for different type of bio-medical waste and it was suggested to implement strict legal provisions for the defaulters [9].

III. METHODOLOGY

The management of bio-medical waste is carried out in six different steps. According to CPCB, India, the initial five steps of segregating, collecting, pre-treating, transporting and storing are the sole liability of the Health Care Facility (HCF), and the last step i.e. treatment and disposal is primarily responsibility of the Common Bio-Medical Waste Treatment Facility (CBWTF) operator excluding the infectious waste including laboratory waste. Such type of waste is pre-treated by the health care facility itself.

A. Sources / Generation of Bio-Medical Waste in Kota

The magnitude of bio-medical waste is only 10% to 15% of the total waste produced by the health care facilities. The bio-medical waste includes such materials that have remained in contact with the infected parts, secretions or blood of patients, medicines, chemicals, biological liquids, lab discharges, metallic and glassware sharps etc. [11-12]

The quantification and characterization study carried out in Kota by State Pollution Control Board Rajasthan reveals that bio-medical waste constitutes 3% of the total municipal solid waste being generated, which is a high alarming situation and needs to be taken on priority by the concerned authorities. The details of total number of beds in all the government and private hospitals of Kota city are given below in Table-I.

Table-I: Number of Beds in Hospitals of Kota city

Name of Hospital	No. of Beds
Govt. Medical College Kota	695
MBS Hospital Kota	750
J K Lone Hospital Kota	307
District Hospital Rampura, Kota	80
New Govt. Medical College Kota	300
Sub Total	2123
All Govt. CHCs in Kota	97
Total	2220
All Private Hospitals in Kota	2280
Grand Total	4500

According to a report of State Pollution Control Board Rajasthan, 314 Kg/day of bio-medical waste is generated in Kota city. According to norms approved by the CPCB, India, the production of bio-medical waste varies from 0.3 to 1.0 kg/bed/day. Therefore, if we adopt a mean value of 0.65 kg/bed/day, then the overall bio-medical waste generated in Kota is 2925 kg per day.

B. Classification of Bio-Medical Waste

Bio-Medical Waste Management (BMWM) Rules, 2016 categorizes the waste produced from HCFs into four types based on the path of separation and colour coding [11-12] as given here:

1. Yellow Category
2. Red Category
3. White Category
4. Blue Category

The yellow category includes human anatomical waste, outdated or rejected medicines, soiled waste, chemical waste, chemical liquid waste, useless linen, mattresses, beddings infected with blood or body fluids and microbiology, biotechnology and other clinical laboratory waste. The red category consists of infected (recyclable) waste; white category includes metal sharp. The metallic body implants and glassware are considered in blue category.

C. Segregation of Bio-Medical Waste

Segregation is the foremost step for efficient management of bio-medical waste. It reduces the quantity of waste and if performed effectively, it can avoid the mixing of biomedical waste with any other type of waste especially domestic or municipal waste. Segregation helps to avoid the reuse of certain biomedical waste like used syringes, needles and other plastics. Some materials like plastics can be recycled after proper disinfection and these can be reused for non-food grade products. The bio-medical waste produced at HCFs is required to be separated in bags or bins of designated colours at the point of source according to BMWM Rules, 2016. There should be proper placement/pasting of posters and placards in the wards and waste storage areas having instructions and guidelines for segregation of bio-medical waste. There should be sufficient number of bags or bins to collect waste at the point of waste generation. The plastic bags should comply the prevailing norms of Bureau of Indian Standards (BIS) as well as the Plastic Waste Management Rules, 2016. The bio-medical waste handling staff should be provided with personnel protective equipment [11-12].

D. Collection, Packaging and Interim Storage of Bio-Medical Waste

The biomedical waste collection comprises installation of colour coded containers for biomedical waste obtained from different sources. The containers/ bins should be placed in a location such that 100 % collection is achieved. Subsequent to collection, the biomedical waste is stored in specific containers and stored in a proper place. The extent of storage should not exceed beyond 8-10 hours in big hospitals containing more than 250 beds and 24 hours in nursing homes [10-11]. Each container must be clearly labeled with the location so that waste can be traced. Storage point must be clear with a warning sign.

As per BMWM Rules, 2016, the collection of bio-medical waste should be carried out per day from each ward of the HCF at regular interval of time and the timing of collection should be set in such a way that they are befitting to the quantum of waste generated in each ward of the HCF. It is to be kept in mind that normal waste is not collected with bio-medical waste.

The bags or containers should not be filled up fully. After three fourth levels, they should be packed. The plastic bags may either be tied or sealed and not to be stapled. There should be proper stock of bags or containers at all waste collection sites so as to replace the filled ones. The bio-hazard symbol must be printed on each bag or container having date of collection, quantity and type of waste, details of sender and receiver and also a bar code label so that they can be tracked anytime [10-11].

It is a good practice not to allow interim storage of bio-medical waste in the wards of HCF. However, if it is required, it must be kept in the dirty utility area or some other pre-defined location far from the patients' area.

E. Transportation of Bio-Medical Waste

The collected wastes are transported in trolleys or in enclosed wheelbarrow for treatment. The operator should ensure to avoid manual loading. The bags/container containing biomedical wastes must be tied before hauling for treatment. Vehicles used for transportation should be special to avoid contact to, and direct contact with the operator, scavengers and the public. While transporting the containers, it must be properly enclosed.

F. Storage of Bio-Medical Waste

Each HCF has to make sure that there is a pre-defined location within its premises to temporarily store the bio-medical waste, until it is picked up and taken for treatment and final disposal at the common bio-medical waste treatment facility. This central waste collection facility under lock and key should be looked after by a responsible employee. The selection of site for such facility as well as the storage capacity should be designed after considering all necessary requirements. Normal waste of the HCF need not be stored in central facility created for bio-medical waste.

G. Treatment of Bio-Medical Waste

The treatment of bio-medical waste starts with basic disinfection to incinerating the waste to ash. The treatment alternatives vary according to the category of waste. For example, syringes are first cut and then disinfected chemically with 1% bleaching powder solution at the place of generation before they are buried into pits. Similarly, contaminated plastics are first disinfected chemically or autoclaved, shredded, recycled and then sent for final disposal with domestic waste. There are a lot of disposal options for biomedical waste disposal similar to the treatment options.

According to the BMWM Rules, 2016, the treatment and disposal of bio-medical waste BMW produced from the health care facilities must be carried out as per the standards provided in these rules. The HCFs are not allowed to establish their own treatment and disposal facility, if there is a CBWTF functioning within 75 Km of radius. In such case, it is mandatory for each HCF to provide its bio-medical waste to nearby CBWTF for treatment and further disposal. In absence of any CBWTF within 75 Km, with the permission of concerned State Pollution Control Board, the HCF has to either supply any willing CBWTF beyond 75 Km or to treat and dispose the BMW in a captive facility or adopt deep burial method.

The common methods for treatment and disposal of BMW are briefly explained as below:

i) Incineration: Most of the hazardous biomedical wastes are treated by the method of incineration to decrease organic and flammable waste to inorganic flame-resistant matter. Incineration is a high temperature, dry oxidation process that results in noteworthy decline of waste weight and volume. Wastes that cannot be reused and recycled or pose problem in disposing in landfills are treated by incineration. Examples of wastes that cannot be incinerated are chemical wastes, wastes containing high mercury or cadmium silver salts, photographic or radiographic wastes and halogenated plastics like PVC. The advantages of incinerator include high reduction of waste volume in addition to good disinfection competence. It helps to save the space in the landfill. The ash generated can be disposed of safely in the landfills. The major disadvantage of incineration includes high operating cost as they are energy intensive process. Also it releases a huge amount of atmospheric pollutants.

ii)Autoclave: Autoclave treats the bio-medical waste through the mechanism of disinfection. If the residence time of autoclave is not less than 60, 45 or 30 minutes, the temperature should not be less than 121°C, 135°C or 149°C with the pressure of 15, 31 or 52 pounds per square inch (psi) respectively.

iii) Microwave Treatment: Microwave treatment uses a frequency and wavelength of 2450 MHz and 12.24 cm, respectively for the destruction of microorganisms. The infectious contaminants in water with biomedical waste are destroyed by heat conduction when it is rapidly heated by the microwaves. The biomedical waste is subjected to heat up to a temperature of 97-100°C by means of microwaves in treatment chamber. Most infectious wastes except human body parts and organs, infected dead animals and metal objects are suitable for treatment by microwave technique. This method shows good disinfection competence with good waste shrinking capacity. Similar to incineration this method also involves high operating costs.

It is an eco-friendly process with potential operation and maintenance problems.

iv) Deep Burial: Deep burial process is done in pits or trench of around 2 meters deep. The pits are partially filled with waste, then 50 cm soil and finally again with waste. The pits are covered with galvanized iron / wire meshes. The deep burial site should be impermeable with no shallow well in the nearby area. The pits should be away from the habitation to avoid contamination of water resources. The site selected should not be in a submerged or eroding zone and should be approved by the authority.

IV. RESULTS AND DISCUSSION

A. Segregation of Bio-Medical Waste

The Fig.1 and 2 shows that posters and bins are available as required according to BMWM rule 2016. During the visit of hospitals, it was found that if hospital staff did not have bag of right colour then they use different colour bag whichever is available. It is one of the biggest loopholes in the system of BMWM of Kota.

Fig. 1: Poster with instruction to use proper colour coded bag during segregation

Fig. 2: Different colour coded bins used for segregation

After complete filling of bag, the hospital cleaning staff brings it to bio-medical waste store. It was found that bags are not packed properly and some part of bio-medical waste was scattered on the floor of the store.

During the visit of storage room of bio-medical waste, as shown below in Fig. 3, it was found that a worker was trying to segregate the waste in the store of BMW at govt. medical college Kota and according to rules this is not the right place to segregate the waste.

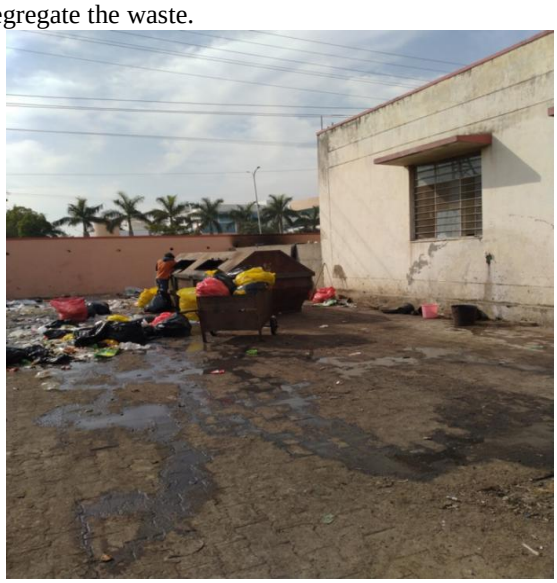

Fig. 3: A worker segregating the bio-medical waste at storage point

Fig. 4 shows the generation of leachate during the process of segregation at storage point. The person employed for segregation was not well educated and does not have any technical training regarding bio-medical waste. It was also seen that the hospital did not provide him any safety equipment for his protection. Also, he did not know about colour combination as per BMWM rule. He was just putting BMW in any bag and after filling that bag, he was putting the waste in another bag.

Fig. 4: Leachate flowing at the storage point

The Fig. 5 below shows that the bio-medical waste is accumulated near MBS hospital on a shop of scrap dealer. It shows that the monitoring of hospital management is poor otherwise it would have not happened.

Surprisingly, it was told by the shopkeeper that hospital staff has sold it to him.

Fig. 5: Bio-medical waste found at a scrap dealer shop near MBS hospital, Kota

B. Collection of Bio-Medical Waste

There were two companies concerned with the management of Bio-medical waste up to year 2015-16, namely Rajdeep Biotech and Hoswin Incinerator Alwar. Rajdeep Biotech was collecting waste from the hospitals under the Govt. Medical College and some private hospitals. Hoswin Incinerator was collecting waste from the hospitals under the Chief medical and health officer Kota and some private hospitals. Fig. 6 below shows that bio-medical waste is not collected timely. It was found that bio-medical waste was not collected from Mahaveer Nagar, Kota dispensary for more than 10 days.

Fig. 6: Container full of bio-medical waste shows that waste is not collected timely

The dispensary staff told that they inform the concern agency once in a week and many times, they burn it themselves, as shown in Fig. 7. It may be very hazardous for human health and environment.

Fig. 7: Bio-medical waste burned by the staff itself at Mahaveer Nagar, Kota dispensary

C. Packaging and Storage of Bio-Medical Waste

During study, it was found that most of the packets are filled two third which is according to the rules but packages were not sealed properly, as seen in the Fig. 8. Also, many bags, though packed properly did not have proper tags and bar codes on them, as shown in Fig. 9. This is violation of BMWM rules.

Fig. 8: Improper packing and segregation noticed at Govt. Medical College Hospital, Kota

Fig.9: Bio-medical waste collection bags without any tags and bar codes seen at MBS Hospital, Kota

For interim storage of bio-medical waste at hospitals, it was found that most of the hospitals have designated a separate room or point for storing the waste till it is transported. The Fig. 10 and 11 below shows storage points at MBS hospital and Govt. Medical College, Kota. It was found that rather than storing waste in a closed room, it is stored in a close wall boundary only which is easily accessible by any person or animal. During rainy season, bio-medical waste is mixed with rain water and high concentration of leachate is generated and carried away with surface water flow, contaminating water for further consumption by human or animals.

Fig.10: Bio-medical waste storage point at MBS Hospital, Kota

Fig.11: Bio-medical waste storage point at Govt. Medical College Kota

D. Transportation of Bio-Medical Waste

According to the guidelines of CPCB, India, closed trolley or container having wheels should be used for transportation of waste but it was found that open trolley was being used for transportation as shown in Fig. 12. Further the trolley was not designed for specific purpose of transportation of bio-medical waste only. It was used for general and multiple tasks. The hauling of bio-medical waste from storage point to the treatment and disposal site was carried out through a closed vehicle, as shown in Fig. 13, but unfortunately, it is unknown where this bio-medical waste is being transported because there does not have any treatment plant or site for bio-medical waste in Kota.

Fig.12: Trolley used for in-house transportation of bio-medical waste

Fig.13: Vehicle employed for transportation of bio-medical waste from storage point to the treatment site

In nutshell, the findings of the study can be summarized, as shown in the following table II:

Table II: Status of Processes involved in BMW

S. No.	Process / Step involved in BMW	Remarks
1	Segregation	Not executed at the source
2	Collection	Not performed properly by the concern agency
3	Packaging and Storage	Not sealed properly
4	Transportation	Closed trolley not used
5	Treatment and Disposal	No facility for treatment is available in Kota

V. CONCLUSION

It has been observed that in absence of proper monitoring, the guidelines of BMWM rules, 2016 cannot be implemented properly. At every step, be it segregation, collection, storage, transportation or treatment and disposal, there is negligence on the part of authorities as well as the operating agencies. Segregation is practiced at the storage point which should actually be carried out at the generation point of bio-medical waste. Collection of waste is not done timely and not stored in designated closed room. In some cases HCF workers burn bio-medical waste in open area, this is not permissible at all. In-house transportation of waste is also not carried out in closed trolley. There is an acute shortage of staff employed by the operator of CBMWTF. The staff at hospitals and that of CBMWTF does not have proper safety equipment with them. There is only one vehicle deployed for collection and transportation of waste, which is not sufficient looking to the large number of hospitals in Kota spread across a vast area. As per official records, bio-medical waste from Kota is currently transported to Alwar for treatment and disposal, which is far away from Kota. It has been noticed that there is no monitoring at any level whether the waste has reached to Alwar or not. It was also found that there is a lack of awareness among all the stakeholders about the provisions of BMWM rule, 2016.

Therefore, it is concluded that the status of bio-medical waste management is very poor in Kota and there is an immediate requirement to take necessary action at the level of government and local authorities as well as the public representatives and resolve this issue related to human health and environment on priority.

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