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RESEARCH ARTICLE

FROM PAPER TO PRACTICE: BIOMEDICAL WASTE MANAGEMENT IN A TERTIARY CARE HOSPITAL IN NORTHERN INDIA

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Abstract

Introduction: India has notified the Biomedical Waste Management Rules, 2016 (BMWM Rules, 2016) for the proper handling and management of Biomedical waste (BMW) and specifies that every healthcare facility shall take all necessary steps to ensure that BMW is handled scientifically without causing any adverse effect on human and environmental health. The new rules established by Government of India, are meant to contain environmental pollution and achieve the goal of clean and green environment. The major steps involved are proper segregation, transportation, and scientific disposal and treatment methods of BMW besides regular monitoring. Therefore, proper protocols should be in place for implementation of the BMWM rules, 2016.

Objective: This study has been undertaken to study the biomedical waste management process, practices and disposal chain adopted in our tertiary care hospital with regard to the BMWM rules 2016.

Material and Method: This is a cross-sectional institutional based retrospective study to assess the implementation of BMWM rules-2016 by the occupier. The duties of the occupier as stated under Section 4(a-t) in the BMWM rules 2016 were grouped into six process areas; 1.Regulatory compliances 2. Hospital Biomedical Waste management which included; i) Waste segregation ii) Pre-treatment of laboratory and highly infectious waste, iii) Intra-mural transport, iv) Temporary storage, 3. Trainings on BMWM, 4. Immunizations, 5. Occupational safety, and 6. Record maintenance.

Conclusion: BMWM rules 2016 envisages regulating the disposal of various categories of BMW so as to ensure safety of the human life and the environment. We live in an evolving era and greater research into eco-friendly sustainable technologies is critical to ensure the fundamental right to live in a clean and safe environment.

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Introduction:-

Biomedical waste (BMW) is any waste produced during the diagnosis, treatment, immunization of human or animal research activities pertaining thereto or in the production or testing of biologicals or in health camps.¹ BMW includes anatomical waste, sharps, laboratory waste, and others and, if not carefully segregated, poses a grave threat to human health and to the environment both for the present and future generations.² Approximately 10%–25% of BMW is categorized as hazardous, while the remaining 75% - 95% is considered non-hazardous.³ It is this hazardous fraction (15%-25%) of the waste that poses potential physical, chemical, and/or microbiological risks to both the general population and healthcare workers involved in the handling, treatment, and disposal of such waste.⁴ The infectious and sharp waste can cause transmission of HIV, hepatitis B and C infections.⁵ Inappropriate segregation of dirty plastic, cytotoxic and recyclable material, might harm our ecosystem and unbalance our ecological balance.⁶

BMWM follows the cradle to grave concept which is a regulatory framework that governs the management and disposal of the hazardous waste. This framework mandates that the biomedical waste journey is documented from the point of generation (cradle) to the point of final disposal (grave) and the generator is responsible for characterization, quantification, segregation, storage, transport, and treatment of BMW.⁷ The basic principle of good BMW practice is based on the concept of 3R's- Reduce, Reuse, Recycle, which aims at minimizing generation of waste, reusing products as much as possible, rather than disposing and recycling. Therefore, waste should be segregated at source rather than following an "end of pipe approach."⁸

Scientific handling of BMW is of critical importance to curb the spread of infections, besides being a legal and social responsibility. The "occupier" means a person having administrative control over the institution and the premises generating bio-medical waste, which includes a hospital, nursing home, clinic, dispensary, veterinary institution, animal house, pathological laboratory, blood bank, health care facility and clinical establishment, irrespective of their system of medicine and by whatever name they are called. The rules clearly define the duties of an occupier under section 4(a-t) of the BMWM rules 2016.¹ We present the current practices established for implementation of BMW rules 2016 in our tertiary care hospital with regards to the role of an occupier.

Objective:-

The aims and objective of this study was to assess the processes, practices and disposal chain adopted for implementation of the BMW rules-2016 in our tertiary care hospital, identify both good practices and gaps and to suggest solutions for closure of gaps.

Material and Method:-

This is an institutional based cross-sectional study conducted from November 2018 to October 2023 for a period of 5 years in our newly opened tertiary care hospital in District Mandi, Himachal Pradesh. We present a report of the implementation of BMWM rules 2016 in our tertiary care hospital with regards to the role of an occupier as mandated in the rules. The parameters for assessment were based on duties of the occupier as outlined in the BMWM rules 2016, Section 4(a-t). The duties of an occupier have been grouped into six process areas. 1. Regulatory compliances, 2. Hospital Biomedical Waste management: This included i) Waste segregation ii) Pre-treatment of laboratory and highly infectious waste iii) Intra-mural transport and iv) Temporary storage, 3. Trainings on BMWM, 4. Immunizations, 5. Occupational safety and 6. Record maintenance

Results:-**Regulatory Compliances:****Authorizations:**

The hospital started functioning in November 2018. All the relevant authorizations under BMWM rules 2016 were granted by the HP State Pollution Control Board for establishment and functionality of the hospital.

Notification of BMWM Committee:

As per BMWM rules 2016 the Biomedical Waste Management Committee has been established to review and monitor the activities related to bio-medical waste management in the institution and uploaded on the college website. The Biomedical Waste Management Committee holds regular meetings every six months on a well-defined agenda, and action taken report presented in the meetings. The minutes of the meeting are recorded and proceedings of the meeting are sent along with the annual report to the PCB.

Hospital Biomedical Waste Management:**Waste segregation:**

The BMW waste generated in the hospital is being segregated at source and placed in colour-coded bags. The sanitation staff is regularly trained and provided with necessary protective gears for handling the waste. Certified non-chlorinated plastic bags are being used for segregation of BMW, however the blood bags as approved by National AIDS Control Organisation (NACO) are being used. Care is taken not to mix treated bio-medical waste with municipal solid waste. The coloured bins are foot-operated and placed away from the general waste bins to avoid mixing of waste. The barcoding of BMWM bags was started on March 2018, though internal barcoding system has not been established as of now. Segregated waste in colour coded bar-coded bags is handed over after weighing the BMW to the authorized Common Bio Medical Waste Treatment Facility (CBMWTF). The segregation of general and municipal waste solid waste is dealt in accordance to the Solid Waste Management rules 2016.

Pre-treatment of Laboratory and Highly Infectious Waste:

The laboratory waste, microbiological waste, and blood bags are pre-treated in accordance to the NACO guidelines and then transported and stored in the BMW storage room and finally lifted by the authorized CBMWTF for final disposal. Trained staff carries out the autoclaving procedure and a dedicated autoclave is used for autoclaving. The hospital ensures segregation of liquid chemical waste. The hospital is equipped with a dedicated functional Effluent Treatment Plant (ETP) and maintained by a trained staff. The ETP treatment process includes removing suspended particles, dissolved organic matter, and managing sludge disposal. The raw effluent from various processing units is collected in the equalization tank. The equalization tank has a capacity of 12.5 kl and provides buffer of 4-6 hours of holding time.

Intra-mural Transport:

The segregated waste in colour coded plastic bags are transported from different wards of the hospital at designated times, usually twice, morning and evening, on trolleys and a route map for transportation of waste is also followed by the sanitary staff. In the emergency department the BMW generated is transported more frequently. No bar coding is done in individual wards, though records are maintained ward wise.

Temporary Storage:

A safe and secure place has been designated for storage of segregated biomedical waste. The storage room meets all essential requirements. The waste is stored in colour coded bags in designated compartments of the storage room (Fig 1). The BMW storage room is locked with restricted entry so that secondary handling, pilferage of recyclables or entry of any animal does not occur. The segregated biomedical waste in colour coded bags is transported to the storage room wherefrom it is lifted by the CBMWTF operator (Fig 2) authorized by the HP SPCB. The BMW is weighed and bar-coded at this point and all categories of BMW are scientifically handled and disposed of by the CBMWTF. The hospital and the authorized CBMWTF have a valid contract and the operator collects waste within 48 hours as given in the contract and usually the bio-medical waste is collected within the agreed time. The hospital does not operate an incinerator or a hydroclave.

**Fig 1:- BMW Storage Room.****Fig 2:- CBMWTF Vehicle.**



Fig 3:- Onsite Training.

Fig 4:- Classroom Training.

Trainings:

Regular trainings both onsite and skill-based trainings are being given to all the staff. Induction training is imparted to all to the new recruits. During this period a total of 1868 health care workers have been trained on the BMWWM rules 2016. A structured questionnaire was constructed in English language for the trainings. For sanitation workers a customized questionnaire in Hindi language was made. A pre and post-test questionnaire was administered to each participant before and after imparting the structured training. The number of trainings and trained personnel during these years is depicted in table 1.

All categories of HCWs including doctors, nursing personnel and sanitation workers have participated in this training program. (Fig 3&4).The average gain index +5.73, +5.08, + 6.66, 0.26, + 8.36 and +1.70 among doctors, ward sisters, staff nurses, ward attendants, operation theatre assistants and sanitation workers respectively was noted. The gain index was statistically significant among doctors and nursing personnel.

Table 1:- Trainings imparted on Biomedical Waste Management.

Year	Number of Class room trainings	Number of Onsite trainings	HCW trained
2018	03	0	152
2019	5	51	479
2020	56	52	1264
2021	21	53	897
2022	10	88	872
2023	17	223	1868
Total	112	467	5532

Immunization:

Most health care workers and sanitation staff, involved in handling of bio-medical waste are being immunized for Hepatitis B, and Tetanus toxoid. Due to transfers and turnover of the staff not all staff has received two doses of Hepatitis B. However, a total of 2,485 doses of Hepatitis B have been administered to employees and Injection Tetanus toxoid to all sanitation staff.

Occupational Safety:

The sanitation staff is out sourced and to ensure occupational safety to all health care workers and others involved in handling of biomedical waste are provided appropriate and adequate personal protective equipment (heavy duty gloves, boots, aprons and masks) by the outsourced agency. The outsourced company also provides regular supply of cleaning equipment, detergent and hypochlorite according to the contract signed with the outsourced company. Though the staff uses protective gears to safeguard themselves from any occupational hazard but at times a complacent attitude is noted among the sanitation workers and seen without boots and aprons. During 2019 to 2023 a total 157 needle stick injuries (NSI) have been reported among the HCWs. The maximum number of NSI have been recorded in nursing personnel (69) which includes 60 nursing students, followed by sanitation workers (60). The record shows that 4 doctors and 15 internship undergoing doctors had encountered NSI. The rest 9 were recorded in laboratory technicians. The results show that supervised handling of sharps is important to avoid NSI as maximum numbers of cases have been recorded in trainee nurses or interns. The sanitation workers have had NSI during transportation of waste, implying improper handling of sharps. Though in the trainings conducted it is apparent that they possess adequate knowledge but easy going attitude could lead to NSI.

Though immediate reporting of NSI and sharp injuries is done which indicates awareness among the staff to report the NSI but at the same time it indicates inadequate prevention plans in place. All the staff is advised to undergo a routine health check up on yearly basis. However, out of 810 HCWs only 244 health care workers have records available for the same.

Record maintenance:

The annual report is compiled and sent by due date to HPPCB mentioning all details as required (immunization, waste generated, needlestick injuries in the proper format) including nil reporting. The records on day to day basis are documented on the bio-medical waste management register. The monthly and yearly report is uploaded on the collegewebsite. <http://www.slbsgmcm.in/index.php/department-of-microbiology>. Other relevant records which include training record, NSI record, gap analysis, water surveillance record, and infection control records are also meticulously maintained.

Sewerage Treatment Plant (STP):

A 900 KLD STP based on moving bed bioreactor technology is established within the college and hospital premises. It caters the hospital and residential sewage within the campus. The functionality of the STP is regularly monitored by trained staff. There is no foul smell and the surrounding area well maintained and green. Regular effluent samples are collected by the HP PCB from the STP and have conformed to the standards prescribed in the BMW rules 2016.¹

A study visit was conducted by the National Productivity Council, and their report highlighted that the BMW (Bio-Medical Waste Management) practices at SLBSGMCH is taking all necessary steps to ensure that biomedical waste is handled without any adverse effect⁸. Additionally, the institution was awarded the State Environment and Leadership Award, first prize in the BMW category by the Department of Environment, Science Technology and Climate Change in the year 2022.⁹

Discussion:-

The BMW rules 2016 applies to all persons who generate, collect, receive, store, transport treat, dispose and handle BMW in any form in hospital nursing homes, clinics, dispensary, veterinary institutions, laboratories, research/educational institutes, campus, first aid rooms of schools, blood banks and Ayush.¹ Biomedical Waste generation depends on the type or level of health-care facility, rural or urban health-care facilities, besides the services provided. Average waste generation rates are calculated in kilograms (kg) per day or kg per year.¹⁰ CPCB reports total generation of biomedical waste in the year 2022 to be 705 tonnes /day¹¹. Our tertiary care hospital is a 500 bedded tertiary care hospital and has generated 1,28,042 kg waste in the year 2022 which is 0.5- 2kg per bed and well within range of hospital waste generation per bed¹².

In order to execute the BMW rules properly all the HCWs of the hospital need to have the correct knowledge and develop attitude and practices. We, in our facility-initiated training from inception of the hospital in 2018 and found encouraging results. All categories of HCWs including doctors, nursing personnel and sanitation workers participate in this training program. The trainings were most helpful to the doctors, nursing personnel and OTAs implying that imparting regular onsite training is important for doctors and nursing personnel. As sanitation workers are more involved in the process of handling waste they have developed an attitudinal change in their work performance. A study conducted in our tertiary care hospital on the training impact on the gain of knowledge among 119 trainee HCWs during the year 2022-2023 was found to be statistically significant.¹³ In another study conducted on efficacy of trainings of newly appointed HCWs cleaning personnel and laboratory assistants who had been working in the hospital for more than 6 months in our newly opened tertiary care hospital an overall significant change was observed in BMW management and general sanitary condition of the hospital.¹⁴ Several studies across the country have reported similar results¹⁵⁻¹⁷. Several authors have shown significant lacunae in the KAP of HCWs regarding BMW, which is a matter of grave concern.¹⁸⁻²⁰

BMW is often source of over 30 dangerous blood borne pathogens.²¹ The hazards of exposure to hospital waste can range from developing gastroenteritis, respiratory and skin infections to more deadly infections like HIV, HBV and HCV. Thus, immunization against HBV infection is important. The literature research regarding vaccination against HBV shows that only 16- 60% of HCWs have received complete HBV immunization, and paramedics have higher risk of HBV transmission but receive less HBV vaccination than doctors.²² The of Indian government has decided to

vaccinate all HCWs who are at risk of HBV. In our HCFs 2,485 have been vaccinated but because of the transfers, all staff and other HCWs could not be vaccinated for 2nd dose.

As per the BMW rules 2016, every occupier has to submit the annual report to prescribed authority (HPPCB) by the 30th June. This compiled report helps to identify the gaps in BMW. There are 3,93,939 number of HCFs in country out of which 1,56,637 have been granted authorization.⁸ The BMW rule stipulates that every health care facility (bedded & non bedded) should obtain authorization otherwise it amounts to violation of BMW rules- 2016 and subject to penalty. Our hospital has a valid authorization till 2025 which needs to be renewed every 5 years.

The National Productivity Council has reported on the good practices on BMW established in the Hospital. Among the good practices the hospital has a systematic development and structuring of records on direct and indirectly linked aspects concerning BMW and their analysis by the hospital for related strengthening initiatives.²³

The major gaps which need to be addressed is to conduct mandatory yearly health check-ups of all the staff, total barcoding, immunization of all health care workers and place stringent protocols for student trainees and sanitation workers while handling BMW. Continued trainings to raise awareness and bring about attitudinal changes in all HCWs are mandatory.

Conclusion:-

Continuous training programmes and waste audits should be encouraged across all HCFs. Not only will it help to create awareness regarding the rules, but also bring uniformity in BMW practices. There is a need to conduct a gap analysis at regular intervals. Several grey areas of concern in BMW rules should be highlighted so that a standard and uniform practice is adopted across the country.

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