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Biomedical waste scenario in India – regulations, initiatives and awareness

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Abstract: Hazardous waste management is more complicated than other environmental problems because of its severe effects on living organisms. Proper classification of hazardous waste at the source can reduce the complexity involved in treatment. Healthcare facilities are expanding in terms of technology and size. Other side of this progress is the potential hazard from the biomedical waste generated from the healthcare activities. Many new viruses and infections are making news in the world. It is the need of the hour to immediately leave lethargic approaches towards the guidelines for hazardous waste management. This article aims at emphasizing the increased need for expansion of biomedical waste treatment facilities. Also, increasing awareness among the health care professionals and the patients about health hazards of biomedical waste can reduce the severity of this problem. Budget and socioeconomic factors limit the selection of technology for biomedical treatment. Efforts are required to minimize the solid waste from healthcare facilities. Based on the rules framed by central governments, state governments are also framing the solid waste disposal rules and standards. Building of biomedical waste treatment facilities in medical universities can help to tackle the problem. Many occupational health hazards from harmful chemicals, toxic formulations, sharp objects and radiations can be reduced with efficient segregation and treatment of the solid waste.

Keywords: waste, infectious, health, hazard, segregation, disposal.

1. Introduction

Hazardous waste has one or more than one characteristic listed in the definition. These characteristics are ignitability, corrosivity, reactivity, and toxicity [1]. It is the waste which poses potential or present hazard to human beings and living organisms because of its properties. This waste may get magnified biologically, or it can be lethal, or because it may otherwise cause or tend to cause detrimental cumulative effects [2]. Hazardous waste management is more complex than other environmental problems because of its severity. Proper classification of hazardous waste at the source can reduce the complexity of the treatment problem [3]. It needs special attention from the government agencies and awareness among people. In the era of rapid industrialization, the use of different chemical compounds, complexes, biological species, and microorganisms is inevitable in research and

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development of new drugs and pharmaceutical products. Also, healthcare facilities are expanding in terms of technology and size. The other side of this progress is the potential and present hazard from the biomedical waste generated from these activities. Many new viruses and infections are making news in the world. Proper treatment of the medical waste can reduce the health hazards caused by biomedical waste. It is the need of the hour to immediately leave lethargic approaches towards the guidelines for hazardous waste management. This article aims at emphasizing the increased need for biomedical waste treatment facilities, awareness among the healthcare professionals and the patients about health hazards of biomedical waste. Some efforts in India for safer biomedical waste treatment are also discussed. There is an improvement in biomedical waste treatment facilities in last few years. There is an urgent need for strict implementation of the rules and regulations from local authorities.

2. Indian perspective

Solid waste treatment facilities in India should be expanded to fulfill the solid waste treatment needs of growing population, which is expected to reach 1.65 billion by 2030 [4, 5]. The number of hospitals and laboratories have increased in cities. Many health care facilities have mushroomed in towns and villages also. In India, about 50 to 60% of the total solid waste generated is biomedical waste [6]. Unsafe practices for biomedical waste are a potential danger to human health in many countries [7]. Sufficient data on the biomedical waste generation and its content is not available, even for cities like Mumbai and Calcutta [8]. Knowledge among the medical college students was also found inadequate in some surveys [9]. Selecting the correct method for waste treatment and setting priorities is not a straightforward task due to budget and socioeconomic factors [10]. Efforts are also required to minimize the solid waste from healthcare facilities [11]. The government is modifying the laws to put more stringent norms for biomedical waste treatment [12, 13]. Also, it is arranging training for biomedical waste treatment for the waste generated from the treatment of novel diseases like Corona Virus [14, 15].

3. Hazardous waste management – rules and regulations

Improper and illegal dumping of solid waste to avoid the treatment cost has made it necessary to plan, frame, and execute strict rules for solid waste management. Many cities have grown in terms of population, living standards, and medical facilities, but the solid waste treatment facilities have not developed to that standard. The medical facilities across Indian cities need to have proper segregation, transportation, and treatment mechanisms. Outside areas of many cities have become illegal dumping and disposal sites [16]. The Indian government, in 2016, reviewed the Bio-Medical Waste (Management and Handling) Rule, 1998 [17]. In the 2016 act, the duties of occupier and operator are defined. According to the act, it is the duty of the occupier to 'take all necessary steps to ensure that bio-medical waste is handled without any adverse effect to human health and the environment'. The operator of common treatment facilities should 'take all necessary steps to ensure that the bio-medical waste collected from the occupier is transported, handled, stored, treated and disposed of, without any adverse effect to the human health and the environment'. Educating the stakeholders involved in medical professions and increasing awareness about adverse effects of biomedical waste can help to minimize the improper disposal, transportation, and lack of segregation of biomedical waste. About 50% of deaths associated with waste-related diseases are due to biomedical waste [18]. Medical waste contains infectious substances and pathogens. Biomedical waste management is a serious concern in developing countries [19]. With the increase of medical facilities, the amount of biomedical waste has also increased rapidly [20]. The public hygiene requirements demand that the huge mass of infectious waste be rendered as harmless as possible. Local pollution control authorities are inspecting the hospitals and their treatment facilities periodically and giving recommendations based on their findings [21]. The state pollution control boards are involved in suggesting classification, segregation, and treatment facilities [22]. The state governments are also framing the solid waste disposal rules and standards based on Bio-medical Waste Management Rules, 2016, and central pollution control boards guidelines [23]. Many investigators in the past have suggested stepwise building of biomedical waste treatment facilities in medical universities [24]. Many occupational health hazards from harmful chemicals, toxic formulations, sharp objects and radiations can be reduced with efficient segregation and treatment of the solid waste [25]. Nwachukwu et al. emphasized the need for effective environmental regulatory surveillance. According to them, some health care facilities such as Medical and Environmental Laboratories are small projects and may not require full blown Environmental Impact Assessment (EIA) [26]. The agencies should develop a module of monitoring their waste disposal [27, 28].

4. Methodologies for treating hazardous waste

Incineration is the most widely used treatment for biomedical waste. The factors considered while deciding the treatment method are disinfection efficiency, exhaust gases generated, volume reduction, area required, locally available technologies, training requirements, regulatory requirements, disposal options available, and public acceptability [29]. Many treatment technologies prevent the adverse effects due to one hazard but creates another hazard. For example, incineration reduces hazardous waste but emits toxic gases. Various types of hazardous waste treatment methods are discussed in this section. These methods include chemical treatment, incineration, microwave irradiation, dry and wet thermal treatment, Land disposal, and inertization.

4.1 Chemical treatment

Chlorine is used to disinfect the biomedical waste. Ethylene oxide treatment is used to sterilize the equipment before reuse. The amount of waste to be treated is an important factor while deciding the treatment method [20]. If the chemicals used are expensive, then chemical treatment methods become uneconomical.

4.2 Incineration

The solid waste containing biomedical or similar hazardous compounds is incinerated if it has a sufficient calorific value (i.e., 1500-2500 kcal/kg). In this method, the toxic organic, combustible matter is reduced in volume and converted into non-combustible inorganic material. This method is used if it is not possible to recycle or dispose of in landfill site [20]. Health care wastes require higher temperatures than other solid waste. Higher temperature reduces odor and pollution. Pyrolytic incinerators are an appropriate choice for infectious and pathological waste. For using this method, the lower heating value (LCV) of the waste should be more than 3500 kcal/kg [29]. The incinerator temperature required is about 1000°C. Rotary kilns can be used operates at 1000-1500°C. Municipal incinerators located in hospital areas can also be used.

4.3 Microwave irradiation

The microwave irradiation method is used only if the waste contains water. It is similar to autoclave. Before treatment, the waste is cut into smaller pieces. This treatment is not suitable for pathogenic waste. Also, this treatment can melt syringes. In this method 99% of microorganisms are killed. This leaves very minimal waste.

4.4 Dry and wet thermal treatment

In wet thermal method, shredded infectious waste is exposed to a high temperature and high pressure steam. When contacted for sufficient time and temperature, most of the microorganisms can be killed by this method. Efficiency of this method is sensitive to the operating conditions [20]. In dry thermal technology, waste is shredded and heated in a rotating auger. Hot oil is used as a heating media and it is passed through central shaft. Infectious waste and sharps can be treated effectively by this method. It cannot be used for radioactive and pathological waste.

4.5 Land disposal

Open dumping and sanitary landfill are two methods for land disposal. Open dumping is unsafe and leads to pollution problems. For sanitary landfill, an isolated area is selected away from the population. The dumping is done in the trenches layer wise and care is taken so that waste is not exposed to the atmosphere.

4.6 Inertization

In inertization, the waste is mixed with cement or another inert material in order to minimize the risk. This method is useful for treating pharmaceuticals and for incineration ashes with a high metal content. Around 30 to 40% of the cement is added to the waste in this method [20, 29].

5. Case studies of biomedical waste management in Indian studies

Many environmental and health problems arise because of improper disposal of biomedical waste. Committed efforts from all the stakeholders in health sectors are required to minimize the biomedical waste pollution. Biomedical waste can cause severe health problems as it may contain different biological microorganisms, drugs and intermediates, and hazardous materials . Biomedical waste can be classified as non-hazardous and hazardous waste. Hazardous waste can further be classified into potentially contagious waste and potentially toxic waste. Scientific judgement and regulatory means can solve the problem of biomedical waste [30].

Few cities in India have implemented the biomedical waste management plan to perfection and have been awarded for municipal solid waste treatment facilities . These can be considered as a case studies for many other Indian cities. In 1993-1994, Surat made headlines for wrong reasons. Very unorganized and careless waste management resulted in rodents appearing on roads and public places. This bad publicity made the municipal authorities and the people to work towards effective waste management. Biomedical waste was a major part of solid waste due to large numbers of medical professionals in the city. Authorities considered the common biomedical waste treatment facilities (CBMWTF) . The deep burial method was used earlier for biomedical waste. The important disadvantage was the improper reuse of dumped material without sterilization. Frequent appearance of infectious diseases prompted the government to frame strict biomedical waste rules. Build, Own Operate and Transfer (BOOT) process was followed while awarding the contract of the CBMWTF facility [31]. The clinic and waste generators were charged based on weight of the waste. Rs 10 per kg waste was the approximate cost of the treatment. Close monitoring of the municipal officers and participation of all the stakeholder was key to success of this biomedical waste management.

Biomedical waste needs to be treated within 48 hours . Dumping and incineration are two widely practiced methods for biomedical waste. Incineration exhaust gases may contain toxic gases. Priyadarshini et al. characterized biomedical waste from Mysuru city hospitals. Approximately 80% of the biomedical waste from hospitals is similar to domestic waste. 15% waste needs to be treated in accordance with its nature . If source separation is efficient, then only about 15% of the biomedical waste needs to have special treatment. In their work, Priyadarshini et al. characterized bottom ash from incineration of the biomedical waste . These samples were digested in acid mixture for metal ion dissolution. Inductively coupled plasma mass spectrometry was used for analysis. Approximately 4,000-6,000 mg/kg of iron, magnesium, and zinc were present in the samples. Copper, manganese, and nickel were present in the range of 1 to 10 mg/kg, while calcium was present in hundreds of mg/kg . The heavy metal separation from the incinerator ash should be carried out based on the concentration of harmful heavy metals in the waste [32]. Some heavy metals are essential and do not affect plant and animal health.

India has more than six lakhs hospital beds and more than 23,000 primary health centers . More than 15,000 private and personal hospitals are also operative. According to the biomedical Waste (Management and Handling) Rules 1998, it is obligatory for hospitals, clinics, and different medical and veterinary institutes to eliminate biomedical wastes strictly in accordance with the guidelines of the government . In the recent past, biomedical waste was disposed of with municipal solid waste. Solid waste from the hospitals is classified as infectious and non-infectious. Infectious waste generally includes the waste containing microorganisms, drug, blood, tissues and other items contaminated with blood and body fluids . Non-infectious waste includes room and workplace waste. It is approximately 85% of the total waste generated in the hospital. According to the biomedical waste management rule 1998, waste that is generated throughout the identification, treatment, or immunizations of people and animals at large is termed as biomedical waste. The waste generated during analysis activities and drug testing activities is also considered biomedical waste [33].

Surprise visits by the officers from regulatory authorities are carried out to check compliance of the healthcare facilities with biomedical waste management rules [18]. An effective communication strategy, awareness, and education can help to reduce biomedical waste problem in India [18, 27]. India faces challenge to treat more than 4.2 lakh kg of biomedical waste per day. It is also necessary to increase the CBMWTF from 150 which is inadequate to treat the waste.

Needles used in the hospitals need very careful handling, as 4 needlestick accidents per 100 beds is a cause of concern in Asian countries and India especially [34]. Hospitals faces the challenge of treating patients with new diseases and treating the biomedical waste arising from this treatment. Basel Convention, Stockholm Convention, and Minamata Convention highlight the international effort to increase the regulatory frameworks for biomedical waste. According to New Rules Notified on 28.3.16, Biomedical Waste Management Rules, 2016, every occupier generating biomedical waste needs authorization. Also, format of annual report on biomedical waste is prescribed. The rule clearly defines the duties of occupiers and operators.

According to a study carried out by Sutha in Chennai for understanding the biomedical waste scenario, lack of awareness and knowledge about biomedical waste among hospital workers is one of the reasons for improper storage and segregation of biomedical waste [35]. Proper training is required for biomedical waste segregation and disposal to avoid the adverse effects of biological and hazardous contents of the waste.

Acharya et al. carried out studies on biomedical waste scenario in Pune, the eight largest city in India and second largest city in Maharashtra [36]. According to this study in 2014, only 25% of the clinics were sending their waste to common solid waste treatment facilities. More than 1,200 kg of biomedical waste is transported 150 km from the city for disposal. About 16% of health establishments in Maharashtra are found in Pune. These contribute with 20% of biomedical waste in Maharashtra [37].

Dhingra et al. studied biomedical waste scenario in Delhi NCR. About 59 metric tons per day of biomedical waste are treated in two common treatment facilities. Biomedical waste generation per day per bed varies from 100 grams to 3,000 grams. For hospitals with 50 to 99 beds, about 5 to 6 tons per day of biomedical waste is generated. For hospitals with 100 beds, about 18 to 20 tons per day of biomedical waste is generated. They pointed out deficiencies in the existing biomedical waste management in hospitals of Delhi, such as lack of strict color coding and record maintenance [38].

6. Conclusions

Healthcare facilities are expanding in terms of technology and size. The other side of this progress is the potential and present hazard from the biomedical waste generated from these activities. Many new viruses and infections are making news in the world. Proper treatment of the biomedical waste can reduce the health hazard. It is the need of the hour to immediately leave lethargic approaches towards the guidelines for hazardous waste management. There is an increased need for biomedical waste treatment facilities and awareness among the health care professionals and the patients about health hazards of biomedical waste. Knowledge among the medical college students was also found inadequate in some surveys. Selecting the correct method for waste treatment and setting priorities is not a straightforward task due to budget and socioeconomic factors. The heavy metal separation from the incinerator ash should be carried out based on the concentration of harmful heavy metals in the waste. An effective communication strategy, awareness, and education can help to reduce biomedical waste problem in India. If source separation is efficient, then only about 15% of the biomedical waste needs to have special treatment. For better public hygiene, the huge mass of infectious waste should be rendered as harmless as possible. Local pollution control authorities are inspecting the hospitals and their treatment facilities periodically and giving recommendations based on their finding. The state pollution control boards are involved in suggesting classification, segregation, and treatment facilities.

Conflicts of Interest

There is no conflict of interest involved in this article.

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