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Investigation of Biomedical Waste Management in Urban Cities

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Abstract:

The study investigates Bio-Medical Waste (BMW) management in Chandigarh, focusing on waste quantity, types, and intervention needs. Inadequate practices, especially in private healthcare facilities, reveal issues like insufficient training and neglect of waste segregation. The current BMW treatment at PGIMER relies on incineration, posing health risks. The study highlights the city's ecosystem and public health impact due to poor waste management. Encouraging proper disposal practices for recyclable waste is crucial. Over 3.5 months, the study measures BMW production, estimating 3500 kg/day in the city. Major contributors include PGIMER, GMCH-32, and GMSH-16. Population growth and urbanization contribute to increasing BMW production. The lack of waste minimization efforts underscores the need for monitoring systems, especially in private facilities. Recommendations include efficient waste minimization, training programs, and awareness campaigns to address BMW management urgently and protect public health and the environment in Chandigarh.

1. Introduction

Bio-Medical Waste may be defined as any undesirable or superfluous by-product, emission, residue or remainder generated by in the course of health care by healthcare professionals, healthcare facilities and other non-healthcare professionals. The unsafe disposal of such waste could have detrimental effects for people who might come into contact with Biomedical Waste. The present study reviews the Bio-Medical Waste (BMW) management practice currently prevailing in City Chandigarh. The main objective of this study is to focus not only on the quantity and type of waste generated from the hospitals but also to identify issues which require intervention by a detailed review of Bio-medical Waste Management practices.

The production of BMW is assessed through direct measurements of produced waste and waste was weighed daily for period of 3.5 months. Segregation of bio-medical waste is not being followed with true spirit because of lack of proper attention, which has not been given to it by the healthcare facilities as their main objective is to provide clinical healthcare to its patients, and this dominates over other objectives like rationalizing the waste-management practices within health-care facilities moreover lack of knowledge about the impacts of improper management of bio-medical waste was observed during personal surveys. Mutilation and disinfection of recyclable waste like plastic tubes and hypodermic needles should be encouraged. As the amount of bio-medical waste has been steadily

increasing due to the increasing human population and urbanization, on an average, BMW production of 3500 kg/day is estimated in the city, and on an average major contribution in the waste quantum is from PGIMER which produces 1000-1200 kg/day, GMCH-32 which produces 500-600 kg/day, and GMSH-16 which produces 150-200 kg/day of bio-medical waste. There is lack of efficient monitoring and inspection system in private healthcare facilities and efforts to reach the goals of waste minimization are missing. Currently, bio-medical waste is generally treated at PGIMER by incineration technology and the incinerated ash is disposed off in the landfills at Ramky Landfill Site, Vill. Nimbua, Derra Bassi, Punjab. Also, it is recommended to control emissions released from incinerators as there are several harmful effects of this, such as the waste can be a major source of dioxin and furan pollution that may pose such health problems as liver failure and cancer..

2. BIOMEDICAL WASTE – GENERATION, SOURCES, AND IMPACTS

Bio-Medical Waste (BMW)

As per the BMW Rules, 2016, the term "Bio-medical waste" encompasses any waste arising during the diagnosis, treatment, or immunisation of humans or animals, associated research activities, or in the production/testing of biological substances, including health camps. Approximately 75% to 90% of waste generated within healthcare facilities is deemed non-hazardous and is comparable to typical domestic waste. This general waste primarily originates from the administrative and housekeeping functions of healthcare establishments, and it may also involve waste produced during the maintenance of healthcare premises [2]. The residual 10- 25% of bio-medical waste is categorised as hazardous, posing potential health risks.

Types of BMW

Infectious waste consists of materials that may contain sufficient bacteria, viruses, parasites, or fungi to cause illness in susceptible individuals. It mainly arises from surgical and autopsy materials of patients with infectious diseases, as well as items used or worn by infected individuals in isolation, including bodily fluids, dressings, and heavily soiled clothing.

Pathological waste consists of tissues, body parts, organs, animal carcasses, blood, and body fluids. Within this category, recognizable human or animal body parts are also called anatomical waste.

Pharmaceutical waste encompasses expired, unused, or tainted medications, vaccines, and pharmaceutical items that are no longer needed and require proper disposal. This category also involves discarded materials involved in pharmaceutical handling, like containers with residues, gloves, masks, tubing, and drug vials.

Chemical waste encompasses disposed chemicals in solid, liquid, or gaseous forms, arising from various activities like diagnostics, experiments, cleaning, and disinfection in healthcare settings. In healthcare, chemical waste is categorized as hazardous or based on specific traits essential for safeguarding health. Hazardous chemical waste is characterized by properties such as toxicity, corrosiveness (like acids with pH <2 and bases with pH >12), flammability, reactivity (including explosiveness, water reactivity, or sensitivity to shock), and genotoxicity (such as cytostatic drugs)[5].

Non-hazardous or general waste refers to waste that hasn't come into contact with infectious agents, dangerous chemicals, or radioactive materials, and doesn't pose a risk of sharps injury. This type of waste constitutes a substantial portion (approximately 85%) of all waste produced by healthcare facilities and typically resembles regular municipal solid waste.

Impact on Public Health

Bio-medical waste includes a large component of general waste and a smaller proportion of hazardous waste. This chapter addresses the potential hazards of exposure to hazardous (or risk) bio-medical waste.

Types of Hazards

Contact with hazardous biomedical waste can lead to illness or harm. The dangerous attributes of biomedical waste stem from factors such as

- Presence of infectious agents.
- A Genotoxic or cytotoxic chemical composition.
- Presence of toxic or hazardous chemicals or biologically aggressive pharmaceuticals.
- Presence of radioactivity.
- Presence of used sharps.

3. Need of BMW Management in Healthcare Facilities:

Certainly, proper biomedical waste management in healthcare facilities is crucial for several reasons:

Preventing Infections: Effective waste management helps prevent the spread of infections among healthcare workers, patients, and the community by safely disposing of infectious materials. Environmental Protection: It safeguards the environment by preventing the release of hazardous substances into the air, soil, or water, thus reducing the risk of environmental contamination and health hazards. Compliance with Regulations: Adhering to waste management regulations ensures healthcare facilities meet legal obligations, avoiding penalties and maintaining compliance with environmental and health guidelines.

Occupational Safety: It ensures the safety of healthcare workers who handle, collect, transport, and dispose of biomedical waste by minimizing exposure to hazardous materials [1].

Public Health Protection: Proper management reduces the risk of diseases spreading through contaminated waste, safeguarding public health in the surrounding community.

Resource Conservation: Efficient waste management practices promote recycling and proper disposal, preserving resources and minimizing the impact on landfill spaces.

Community Engagement: Implementing a robust waste management system involves community participation and awareness, fostering a culture of responsibility and environmental stewardship.

Risk Mitigation: It mitigates potential risks associated with improper disposal, such as injuries from sharps, accidental exposure to harmful chemicals, and contamination of water sources.

Emergency Preparedness: An organized waste management system enhances preparedness for handling unforeseen events or emergencies, ensuring swift and safe waste disposal during crises.

Cost Efficiency: While initial investments may be required, proper waste management systems can lead to long-term cost savings by reducing healthcare-associated infections, regulatory fines, and environmental cleanup costs.

4. RULES OF BMW WASTE

Rules of BMW Management according to Ministry of Environment, Forest and Climate Change, Govt. of India [Published in the Gazette of India, Extraordinary, Part II, Section 3, Sub-section(i)] –

Application: These rules shall apply to all persons who generate, collect, receive, store, transport, real, dispose, or handle bio medical waste in any form including hospitals, nursing homes, clinics, dispensaries, veterinary institutions, animal houses, pathological laboratories, blood banks, hospitals, clinical establishments, research or educational institutions, health camps, medical or surgical camps, vaccination camps, blood donation camps, first aid rooms of schools, forensic laboratories and research labs [8].

Duties of Occupier:

- To provide a safe, ventilated and secured location for storage of segregated BMW within premises.
- Phase out use of chlorinated plastic bags, gloves and blood bags within two years from the date of notification of these rules.
- Provide training to all its health care workers and others involved in handling of bio medical waste.

- Immunisation against Hepatitis B and tetanus for workers.
- Establish a Bar-Code System for bags or containers containing bio-medical waste to be sent out of the premises.

Duties of Operator:

- Report major accidents and remedial measures to SPCB(State Pollution Control Board).
- Ensure timely collection of BMW from healthcare facilities.
- Maintain a log book for each of its treatment equipment according to weight of batch; categories of waste treated; time, date and duration of treatment cycle and total hours of operation.
- Handing over of recyclable waste to after treatment by autoclaving and incineration.
- Establish bar coding and GPS for handling of BMW within one year.
- Provide training for all its workers involved in handling of BMW at the time of induction and at least once a year after.
- Ensure occupational safety of all its workers involved in handling of bio-medical waste by providing appropriate and adequate personal protective equipment.

Treatment and Disposal:

- Occupier shall hand over segregated waste to common bio-medical waste treatment facility for treatment, processing and final disposal.
- Provided that the lab and highly intectious bio-medical waste generated shall be pre-treated by equipment like autoclave or microwave.
- No occupier shall establish on-site treatment and disposal facility, if a service of common medical waste treatment facility is available at a distance of seventy-five kilometres.
- Every operator of common bio-medical waste treatment facility shall set up requisite biomedical waste treatment equipment like incinerator, autoclave or microwave, shredder and effluent treatment plant as a part of treatment, prior to commencement of its operation.
- Segregation, packaging, transportation and storage:
- Bio-medical waste classified in to 4 categories based on treatment options.
- No untreated bio-medical waste shall be kept stored beyond a period of 48 hours.
- If required to store beyond 48 hours, the occupier shall ensure that it does not affect human health and inform the SPCB with reason for doing so.

Monitoring and Implementation of the Rules: Annual Report

- Every occupier shall submit an annual report to the prescribed authority by the 30th of June every year.
- The prescribed authority shall compile, review, analyse and report to the CPCB by 31st July every year.
- The CPCB shall submit a report on the same to the Ministry of Environment, Forest and Climate Change by 31st August every year.
- The Annual reports shall be available on the websites of the occupier, SPCB and the CPCB.

5. Waste Treatment Technologies and Disposal Methods

Incineration is a high-temperature, dry oxidation method aimed at converting organic and combustible waste into inorganic, non-combustible matter, resulting in a significant reduction in both waste volume and

weight. Operating at temperatures ranging from approximately 200 °C to over 1000 °C, these high-heat thermal processes utilize combustion, pyrolysis, or gasification to chemically and physically break down organic materials [4].

Autoclaves have the capability to manage a diverse range of infectious waste, including cultures, sharps, blood-contaminated materials, limited fluid quantities, isolation and surgery waste, laboratory waste (excluding chemical waste), and "soft" waste (such as gauze, bandages, drapes, gowns, and bedding) from patient care settings. Although autoclaves can technically treat small amounts of human tissue with sufficient time and temperature, ethical, legal, cultural, religious, and other factors may impede such treatment.

Irradiation treatment involves configurations utilizing irradiation from sources such as electron beams, cobalt-60, or ultraviolet radiation [6]. To prevent increased occupational exposure to electromagnetic radiation, these technologies require protective shielding.

Plasma pyrolysis represents an advanced technology for the secure disposal of medical waste, offering an environmentally friendly approach that transforms organic waste into commercially valuable byproducts.

6. Healthcare Scenario in Chandigarh

Chandigarh boasts a comprehensive healthcare system encompassing primary, secondary, and tertiary levels. The city features 16 sub-centres, 52 civil dispensaries providing Allopathic, Ayurvedic, and Homeopathic OPD medical services, seven Alternative Medical Units, three Urban Primary Health Centres, two 50-bedded Community Health Centres, one 100-bedded Civil Hospital, a 500-bedded Govt. Multi-Specialty Hospital, a Govt. Medical College and Hospital, and a PGIMER. To address the diverse medical needs of the population, Chandigarh's hospitals offer 24-hour facilities and services, including emergency wards, coronary care units, burns units, intensive care units, and neonatal intensive care units. These hospitals maintain high medical and health standards and house specialized departments like pulmonology, nephrology, cardiology, neurosurgery, urology, neonatology, and plastic surgery [3]. Despite the city's population of 11.69 lakhs according to the 2021 census, the challenge lies in catering to the migratory population from neighbouring states such as Punjab, Haryana, Himachal, J&K, and Rajasthan. In the financial year 2017-18, Chandigarh's government health facilities, including PGIMER, recorded 68.80 lakh outpatient department (OPD) patients, demonstrating the accessibility and popularity of healthcare services in the region [7].

7. REMEDIAL MEASURES FOR BMW MANAGEMENT:

Insufficient and Ineffective Waste Segregation: The study revealed widespread incorrect waste segregation practices in the majority of surveyed hospitals. Mixing general waste with biomedical waste emerged as a prevalent issue, highlighting a lack of prioritization in waste management practices. The absence of regular administrative monitoring underscores the need for enhanced oversight in waste management efforts.

Waste Container Inconsistencies: Healthcare facilities utilize waste containers of varying shapes, sizes, and materials, yet inconsistencies were noted where bin sizes did not align with the volume of waste generated. In several facilities, inappropriate waste containers, such as leaky or partially broken bins, significantly impacted overall cleanliness levels, falling below desired standards [11].

Limited Civic Awareness: Government-run hospitals displayed a deficiency in civic awareness regarding waste minimization, possibly due to lax enforcement of basic rules and regulations.

Inconsistent Waste Collection within Health-Care Facilities: Private healthcare facilities experienced irregularities in waste collection scheduling, often not aligning with the generated waste volume. Instances occurred where private contractors failed to promptly

collect waste, violating Bio-Medical Waste Management Rules, 2016, which stipulate that certain types of waste should not be stored for more than forty-eight hours [9].

Labelling and Signage Issues: The absence of biomedical waste labels on waste carry bags was observed in all healthcare facilities, contravening Bio-Medical Waste Management Rules, 2016, which place the responsibility on waste generators to ensure proper bag labelling.

Lack of Interim Storage in Medical Departments: Healthcare facilities lacked designated utility rooms for the storage of biomedical waste in medical areas, as recommended. These utility rooms, meant for cleaning equipment, dirty linen, and waste, were entirely absent in the observed facilities [10].

Monitoring System Deficiency: There was a lack of a monitoring system for both on-site and off-site transportation of wastes, raising uncertainty about whether wastes collected were being transported to designated treatment and disposal sites in accordance with Bio-Medical Waste Management Rules, 2016.

Current Waste Treatment Challenges: The incinerator at is non-functional at various locations, and mostly the few limited which is working is most of the time shared by all healthcare facilities in Chandigarh, operates with reduced efficiency and deteriorated conditions, posing potential harm to healthcare workers. Additionally, rigorous monitoring of toxic substances, including dioxin emissions, from the incinerators is not being conducted, heightening potential risks to human health and the surrounding environment.

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