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A Comprehensive Review of Biomedical Waste Management

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***Abstract*— The word 'biomedical waste' mentions to any waste produced while diagnosing, treating, or immunizing humans or animals. Effectively managing healthcare waste is a fundamental aspect of infection control and hygiene initiatives within healthcare environments. Ensuring the safe and sustainable handling of biomedical waste (BMW) is a shared social and legal duty, encompassing all individuals who contribute to and fund healthcare endeavors. This article explores the revised 2016 guidelines for Biomedical Waste Management. It covers the origins of biomedical waste, emphasizes the difficulties faced, analyzes conventional approaches, compares the 1998 and 2016 regulations, examines global waste management practices, involvement of stakeholders in the management of biomedical waste and addresses training and awareness. The new guidelines aim to enhance the sorting, transit, and disposal processes, ultimately minimizing ecological contamination and revolutionizing BMW handling and treatment practices in India. Achieving proficient BMW management hinges on collaborative efforts, bolstered by unwavering governmental backing in terms of funding and infrastructure advancement, devoted healthcare personnel and institutions, sustained oversight of BMW protocols, stringent legislative frameworks, and robust regulatory authorities. At its core, BMW management underscores the fundamental tenet of source-based segregation and waste reduction. To achieve enhanced results, it is crucial to enhance the quality of training and education related to biomedical waste and environmentally conscious healthcare. This should be given top priority within the context of regulations and legal provisions.**

Keywords—Biomedical waste, Waste management, 2016, Regulation.

I. INTRODUCTION

Biomedical waste mentions to solid or liquid waste including infectious or likely infectious materials of medical, laboratory, or research origin [15]. The 2016 Solid Waste Management Rules classify solid waste into various categories based on its source and characteristics: municipal solid waste, hazardous waste, construction and demolition waste, plastic waste, e-waste, biomedical waste, and other wastes. Biomedical waste is commonly known as hospital waste or contagious waste because hospital trash contains dangerous components[1].This waste consists of biological agent-contaminated items such used needles, bandages stained with blood, lab cultures, and other potentially contagious items. So as to stop the open out of pathogens and safeguard healthcare professionals, patients, and the environment, biomedical waste management must be done properly. Medical diagnosis, treatment, research, and laboratory work all result in the production of chemical biomedical waste like organic and inorganic chemical waste [10]. Roughly, 10% of the total hospital waste produced is considered hazardous, with around 85% categorized as non risk waste. A small portion, accounting for 5%, is labeled as highly hazardous [6]. The Ministry of Environment and Forest, Government of India, implemented the Bio-Medical Waste (BMW) (Management and Handling) Rules 1998 on July 20, 1998. In this regard, the Armed Forces Medical Services (AFMS) played a pivotal role in establishing effective biomedical waste management systems in its various Health Care Establishments throughout the nation [12].The safe and appropriate handling, collection, treatment, and disposal of waste produced in healthcare institutions are all part of biomedical waste management, an crucial element of healthcare operations [8]. It can present significant ultimatum to both human health and the environment if improperly managed. Infectious disease transmission, water source pollution, and soil contamination can all result from poor biomedical waste disposal.The introduction of novel materials in the market for neutralization, screening, diagnosis, and treatment due to the pandemic disease COVID-19 resulted in an unexpectedly large production of biomedical waste associated with these activities, notably involving biomedical waste from medical processes [11]. After the emergence of the novel coronavirus disease COVID-19, significant quantities of biomedical waste have been produced globally from isolation wards, institutional quarantine centers, and home quarantine measures. The primary contributors to this waste volume include personal protective equipment, testing kits, surgical facemasks, and nitrile gloves [13].The COVID-19 pandemic has transformed previously healthy locations worldwide into grim environments marked by significant death tolls, driven by its rapid transmission. This has led to widespread lockdowns in nearly every corner of the globe. Amidst the myriad challenges it has spawned, one critical issue that could exacerbate the dire and contagious situation within densely populated cities is the improper management of medical waste. Taking the case of Wuhan, China, the initial epicenter of the pandemic, which is home to 11 million residents. During the peak of the outbreak, its hospitals were generating over 240 tons of medical waste daily, a stark increase from the 40 tons produced before the epidemic. China's Ministry of Ecology and Environment's emergency office reported these figures. To address this colossal volume of medical waste, the national government swiftly dispatched 46 mobile medical waste treatment facilities to Wuhan. Additionally, within just 15 days in March, a new plant with a 30-tonne capacity was constructed to tackle this pressing issue . During the outbreak of COVID-19, the production of biomedical waste increased to 102.2% in both public and private hospitals [9]. In India , a large number of biomedical waste is generated which affect the temporal and geographical aspect of environment [5]. The concerning effects of biomedical waste on environment and human health are evident. The improper disposal of increasing quantities of biomedical waste from hospitals and nursing homes is becoming a growing issue. Inadequate waste management practices within these establishments lead to health risks and real environmental challenges [14]. A number of procedures are necessary for effective biological waste management, including waste segregation, appropriate packaging, transportation, and treatment techniques.To ensure the secure processing and disposal of biomedical waste, healthcare facilities must abide by local, national, and international laws and regulations [3,4]. The motive of this introductory overview is to highlight the significance of biological waste management in healthcare environments and to increase awareness of the potential risks connected to inappropriate waste disposal.The need to establish effective and sustainable waste management methods to safeguard both the environment and public health grows as the amount of biological waste rises along with the expansion of healthcare services.

The primary objective is to safeguard public health and the environment from the potential hazards caused by biomedical waste.Minimizing the impact of biomedical waste through efficient practices, proper segregation, and waste reduction techniques.

II. RESEARCH ANALYSIS

A. SOURCE OF GENERATION OF BIOMEDICAL WASTE.

While solid waste management has gained significant prominence, certain specific waste sources, such as biomedical waste, remain inadequately addressed by local authorities. Biomedical waste is a prime example of such a neglected category. Biomedical waste sources can be divided into primary and secondary sources based on the volume they generate. Although small-scale and dispersed sources might yield waste similar to biomedical waste, their composition will differ [1].

Table 1: Origins of biomedical waste generation can be classified into primary and secondary sources.

Primary sources	**Secondary sources**
Hospitals	Sanitation departments
Medical laboratories	Waste collection agencies
Research facilities	Incineration facilities
Dental practices	Waste recycling centers
Veterinary clinics	Landfills

B. SUITABLE SOLUTIONS FOR BIOMEDICAL WASTE MANAGEMENT.

Numerous techniques have proven effective in managing infectious waste. Below are the methods that could potentially be accessible within your facility for waste treatment: Autoclaving, Incineration, Thermal inactivation, Vapor Sterilization, Shredding and Compaction, Chemical Disinfection, and more . Healthcare waste disposal practices in various regions worldwide are summarized in the table below.

Table 2: Distinct approaches to disposing of biomedical waste exist in both developing and developed nations. [16].

Developing Country	**Disposal method**
India	Landfill, Incineration, Autoclaving, Recycling – reuse.
Bangladesh	Dumping
Libya	Dumping, Incineration.
Greece	Recycling-Reuse, Pyrolytic combustion, Landfill.
Malaysia	Landfill, Incineration, Recycling.
Mongolia	Open disposal or open burning, Incineration, Autoclaving.
Developed Country	**Disposal method**
Japan	Incineration, recycling, landfills, land reclamation.
Canada	Incineration, Landfill.
Italy	Recycling, Biological treatment, Landfill, Incineration.
Spain	Landfill, Recycling.
South Korea	Incineration, Landfill.
United States	Microwave, Autoclaving, Pyrolytic combustion, Chemical mechanical system.

- **Autoclaving**

Autoclaving is a broadly used method in biomedical waste management that involves subjecting waste to high-pressure steam at raised temperatures. The main purpose of autoclaving is to sterilize the waste, rendering it free from pathogens and other infectious agents. Here's how the autoclaving process works [9]:

Preparation and Segregation: Before autoclaving, biomedical waste is graded and segregated into categories based on its type and potential risk. Sharp objects like needles and syringes are separated from other waste to avert injuries during handling.

Loading: The segregated waste is placed inside autoclave chambers. It's crucial to secure proper loading to permit steam to reach all parts of the waste, ensuring effective sterilization.

Pressurization and Heating: The autoclave chamber is sealed, and steam is inaugurated under high pressure. The combination of pressure and heat raises the temperature inside the chamber to around 121-134°C (250-273°F).

Sterilization Phase: The waste is maintained at the raised temperature for a specified period, typically around 20-30 minutes. This prolonged exposure to high heat and pressure effectively kills pathogens, including bacteria, viruses, and spores.

Cooling and Depressurization: After the sterilization phase, the chamber is gently cooled down, and the pressure is released. This prevents any recontamination due to sudden temperature changes.

Removal and Handling: Once the operation is complete, the sterilized waste is abolished from the autoclave. It's important to handle the waste with care, as it might still be hot. Sterilized waste is now safe for further handling, transportation, and disposal.

- **Incineration**

Incineration is a method of biomedical waste management that involves controlled burning of waste materials at high temperatures. This process is designed to reduce the volume of waste, eliminate pathogens, and convert the waste into ash, gases, and heat. Here's an overview of the incineration process[9]:

Waste Collection and Segregation: Biomedical waste is collected, segregated, and sorted to separate hazardous and non-hazardous materials. Sharp objects, chemicals, and other potentially harmful items are separated to ensure safe handling.

Loading:The sorted waste is loaded into specially designed incinerators. These incinerators are equipped with systems to control temperature, airflow, and emissions.

Combustion: The waste is subjected to high temperatures, typically ranging from 800°C to 1,200°C (1,472°F to 2,192°F), within the incinerator chamber. This high temperature combustion breaks down organic materials, destroys pathogens, and converts waste into gases and ash.

Gas Treatment: The gases produced during incineration contain pollutants and harmful compounds. To mitigate environmental impact, these gases are treated using scrubbers or other systems that capture and neutralize harmful components before releasing the gases into the atmosphere.

Ash Residue: After combustion, the remaining materials turn into ash. This ash may contain non-combustible materials, such as metals and glass, which require proper disposal.

Monitoring and Compliance: Incineration processes are closely monitored to ensure that temperatures and emissions meet regulatory standards. Continuous monitoring helps prevent air pollution and other environmental impacts.

Cooling and Handling: Once the process is complete, the incinerator is allowed to cool down before the ash is removed. The ash is then managed according to waste disposal regulations.

- **Thermal Inactivation.**

Thermal inactivation is a method used in biomedical waste management to render pathogens and microorganisms inactive through the application of heat. This process involves subjecting the waste to elevated temperatures for a specific duration to ensure the destruction of harmful biological agents. Here's an overview of the thermal inactivation process [9]:

Waste Segregation: Biomedical waste is sorted and categorized based on its type and potential risks. This step ensures proper handling and treatment of different waste streams.

Loading: The segregated waste is loaded into a thermal treatment system, which could be a dedicated chamber or a specialized device capable of maintaining precise temperature control.

Heating Phase: The waste is subjected to controlled high temperatures, usually within the range of 160°C to 180°C (320°F to 356°F). This sustained exposure to heat effectively kills pathogens and microorganisms present in the waste.

Retention Time: The waste is held at an elevated temperature for a duration that typically ranges from 20 minutes to an hour. This retention time is crucial to ensuring that all potentially harmful agents are completely neutralized.

Cooling and Handling: After the thermal treatment, the waste is allowed to cool down before it is removed from the treatment system. The cooled waste is then handled, stored, and transported in compliance with waste management regulations.

- **Shredding and Compaction**

Shredding and compaction are techniques employed in biomedical waste management to reduce the volume of waste and enhance its manageability. These methods involve physically altering the waste to make it more compact and easier to handle. Here's an overview of shredding and compaction:

Shredding:

Waste Preparation: Biomedical waste is collected and sorted into appropriate categories. Sharp objects and potentially hazardous materials are separated to ensure safety during shredding.

Shredding Process: The waste is fed into specialized shredding equipment designed to break down materials into smaller fragments. This process cuts or tears the waste into smaller pieces.

Compaction:

Waste Loading: After waste is sorted, it's loaded into compaction equipment that compresses the waste to reduce its size. Compactors can be mechanical or hydraulic and work by applying pressure to the waste.

Compaction Process: The waste is subjected to pressure, causing it to become denser and occupy less space. This process can involve multiple cycles of compression to achieve desired volume reduction.

- **Vapor Sterilization.**

  Vapor sterilization, also known as gas sterilization, is a method employed in biomedical waste management to disinfect and render items free from pathogens using gaseous agents. This process is particularly useful for materials sensitive to high temperatures or moisture. Here's an overview of vapor sterilization[9]:

  Preparation and Segregation: Biomedical waste is sorted and grouped based on its nature and potential hazards. This initial step ensures that different types of waste are appropriately treated.

  Loading: The segregated waste is placed within a chamber designed for vapor sterilization. The chamber must be sealed to prevent the escape of the sterilizing gas.

  Gas Introduction: A sterilizing gas, such as ethylene oxide (EO), hydrogen peroxide, or ozone, is introduced into the chamber. The gas effectively penetrates porous materials and kills microorganisms, including pathogens.

  Exposure Time: The waste remains exposed to the sterilizing gas for a specific period, often ranging from a few hours to several hours. The duration is essential to ensure thorough disinfection.

  Aeration and Degassing: After sterilization, the chamber is ventilated to remove the sterilizing gas. This step may involve aeration and degassing to eliminate any residual gas and prevent potential harm to individuals handling the sterilized items.

  Monitoring and Safety Measures: Vapor sterilization requires careful monitoring of gas concentration and exposure time. Adequate safety measures, such as proper ventilation and gas detection systems, are crucial to safeguard personnel.

  Handling and Storage: Once the sterilization process is complete, the items are handled and stored in accordance with waste management guidelines.

- **Landfill Disposal**

Landfill disposal is a method of biomedical waste management where treated waste that poses no significant risk is safely disposed of in designated landfill sites. This process involves carefully placing the waste in engineered landfills designed to minimize environmental impact and prevent contamination. Here's an overview of landfill disposal:

Treated Waste: Biomedical waste that has undergone proper treatment, such as autoclaving or other disinfection methods, and poses minimal or no health and environmental risk, may be suitable for landfill disposal.

Waste Preparation: Before disposal, the waste might undergo processes like shredding or compaction to reduce its volume and enhance its compatibility with landfill storage.

Landfill Selection: Landfills used for biomedical waste disposal must adhere to stringent regulatory guidelines. These landfills are engineered with liners, leachate collection systems, and gas control measures to prevent groundwater and air pollution.

Landfill Placement: The treated waste is placed in designated areas within the landfill site. It's important to segregate different types of waste and follow guidelines for proper placement to prevent any potential contamination.

Covering: Once a certain amount of waste is placed, it is covered with layers of soil or other materials to prevent odors, scavenging, and the spread of waste.

Monitoring and Maintenance: Landfills require ongoing monitoring to ensure they don't negatively impact the environment. This includes checking for gas emissions, leachate levels, and potential groundwater contamination.

- **Chemical Disinfection**

Chemical disinfection is a method utilized in biomedical waste management to neutralize pathogens and microorganisms present in waste using various disinfectants. This process involves the application of chemical agents to effectively destroy or deactivate harmful biological agents. Here's an overview of chemical disinfection[9]:

Waste Sorting: Biomedical waste is segregated and classified based on its nature, potential hazards, and the types of pathogens it may contain. Proper sorting ensures that waste is treated appropriately.

Preparation: Before applying disinfectants, the waste may undergo initial steps like shredding to enhance the effectiveness of the chemical treatment.

Disinfectant Application: Disinfectant solutions, such as chlorine-based compounds, hydrogen peroxide, or other approved chemicals, are applied to the waste. These solutions effectively break down pathogens and microorganisms.

Exposure Time: The waste is allowed to remain in contact with the disinfectant solution for a specific duration, ensuring that all potentially harmful agents are neutralized.

Rinsing or Deactivation: After the exposure time, the waste may need to be rinsed or treated to deactivate the disinfectant or remove any residue that could be harmful during further handling.

Safety Measures: Chemical disinfection requires proper protective gear and ventilation to ensure the safety of workers handling the waste and applying the disinfectant.

Regulatory Compliance: The selection and use of disinfectants should comply with relevant regulations and guidelines to ensure effective waste treatment and worker safety.

Handling and Storage: Once the disinfection process is complete, the waste is managed, stored, and transported in accordance with waste management regulations.

C. INVOLVEMENT OF STAKEHOLDERS IN THE PROPER MANAGEMENT OF MEDICAL WASTE DISPOSAL.

Effective disposal of biomedical waste necessitates a comprehensive examination, highlighting the importance of all parties comprehending their respective roles and duties in the process[17].

- Policy makers: Similar to other endeavors, securing enduring outcomes requires a dedicated involvement from policymakers. Their responsibilities extend beyond formulating laws to encourage the proper management of biomedical waste. They also encompass advocating for economical waste disposal methods tailored to the diverse types of waste and changing seasons.
- Hospital administrators: The hospital administrator is tasked with creating a tailored yet all-encompassing waste management policy based on the generated waste type. This involves appointing a nodal officer or establishing a waste management committee. This committee is then responsible for devising a staff training regimen, advocating for the adoption of universal safety protocols and disinfection methods and maintaining hospital cleanliness overall.
- Healthcare personnel: Healthcare personnel play a pivotal role in guaranteeing the secure disposal of biomedical waste. To address current gaps, strategies such as raising awareness, arranging training, encouraging consistent hand hygiene, and engaging undergraduate medical students have been suggested. Furthermore, health professionals bear the responsibility of preventing the generation of avoidable hazardous waste through diligent measures.

The stakeholders encompassed by the renders of the Biomedical Waste Management Rules 2016 can be illustrated as follows:

Table 3: Stakeholders mantled under Bio Medical Waste Rules 2016

Occupier	Operator	Prescribed authorities
1.Hospitals. 2.Nursing home. 3.Clinic/clinical establishment. 4.Dispensary. 5.Veterinary institution. 6.Animal house. 7.Pathological laboratory. 8.Blood bank. 9.Health care facility.	The responsibilities of facility arrangers of common biomedical waste treatment facilities encompass: 1.Collection 2.Reception 3.Storage 4.Transport 5.Treatment 6.Disposal 7.Any other setup of handling BMW.	1.MoEF &CC. 2.Central or State Ministry of Health & Family Welfare, Central/State Ministry for Animal Husbandry & Veterinary. 3.Ministry of Defense. 4.Central Pollution Control Board. 5.State Govt. of Health for Union Territory Govt. or Administration. 6.State Pollution Control Board/Committee. 7.Municipalities/ Corporations, ULBs and Gram Panchayats.

D. KEY POINTS FROM THE BIOMEDICAL WASTE MANAGEMENT RULES OF 2016 .

Table 4: Color Coding – Biomedical Waste Management Rules, 2016 [7].

Yellow	Human Anatomical waste Animal Anatomical waste Soiled waste Discarded or expired medicine Laboratory waste Chemical waste Chemical liquid waste
Red	Contaminated waste (Recyclable)

White	Waste sharps including metals
Blue	Glassware Metallic body implants

Table 5: Waste Categories, their treatment and disposal methods [7].

WASTE CATEGORY	**TREATMENT AND DISPOSAL**
Human Anatomical Waste Animal Anatomical Waste Soiled Waste	Incineration or deep burial or Plasma Pyrolysis
Expired or discarded medicines	Cytotoxic drugs that have expired and items contaminated with such drugs are to be sent back to the manufacturer or dealer for incineration at temperatures exceeding 1200°C. Alternatively, they can be directed to a CBMWTF or a hazardous waste treatment, storage, and disposal facility for incineration at temperatures exceeding 1200°C. Encapsulation or plasma pyrolysis at 1200°C are also viable disposal methods.
Chemical waste	The disposal methods include incineration, plasma pyrolysis, or encapsulation within a hazardous waste treatment, storage, and disposal facility.
Chemical liquid waste	Subsequent to the recovery of resources, any chemical liquid waste must undergo pretreatment before being combined with other forms of waste.
Discarded linen, mattresses beddings contaminated with blood or body fluids	Nonchlorinated chemical disinfection is carried out, followed by the options of incineration, plasma pyrolysis, or utilization for energy recovery.
Microbiology, biotechnology, andother clinical laboratory waste	The waste is initially pretreated on-site using non-chlorinated chemicals in accordance with NACO or WHO guidelines to achieve sterilization. Following this, the waste is directed for incineration.
Contaminated waste (recyclable)	After autoclaving or microwaving/hydroclaving, the waste undergoes shredding or mutilation, or a combination of sterilization and shredding. The treated waste is then directed to registered recyclers or used for energy recovery, plastics to diesel or fuel oil conversion, or repurposed for road construction.
Waste sharps including metals	Autoclaving or dry heat sterilization is dogged by shredding, mutilation, encapsulation in a metal container, or cement concrete. Alternatively, a combination of shredding and autoclaving is performed before sending the waste for final disposal to iron foundries.
Glassware Metallic body implants	The process involves disinfection, autoclaving, microwaving, or hydroclaving, followed by recycling.

E. CHALLENGES IN BIOMEDICAL WASTE MANAGEMENT.

Healthcare establishments refer to locations where the diagnosis, treatment, immunization of humans or animals, as well as research activities, occur as outlined in the BMWM Rules of 2016. By the year 2017, there were 238,170 healthcare facilities operating across various Indian states and Union Territories. These establishments comprised both bedded (37%) and non-bedded (63%) facilities. Over this period, the total count of available beds witnessed a 32% growth, reaching 675,670 beds in comparison to the count in 2008, which was 1,418,984 beds.

- Treating biomedical waste at a rate of 710 tonnes per day, complying with the provisions of the Bio-Medical Waste Rules[8].
- The need to significantly expand the count of Common Bio Medical Wastes Treatment Facilities (CBMWTF) is evident. Currently, the existing 208 facilities are insufficient to manage the entirety of generated biomedical wastes.
- Encouraging the adoption of novel technologies for the eradication of hazardous biomedical wastes.

F. TRAINING AND AWARENESS.

Comprehensive management of biomedical waste relies on a blend of education and awareness efforts. Education and dissemination of knowledge ensure that healthcare personnel, waste handlers and the general public understand the criticality of safely and responsibly managing biomedical waste. The following aspects underscore the importance of education and knowledge regarding biomedical waste management:

Training Initiatives: Regular training programs should be implemented in healthcare facilities to enhance the awareness of healthcare workers about the risks associated with biomedical waste. These programs should emphasize correct waste segregation, safe handling practices, and the utilization of personal protective equipment (PPE) to minimize exposure risks.

Standardized Operating Protocols (SOPs): Develop and widely distribute detailed SOPs outlining the procedures for managing biomedical waste. These SOPs should provide step-by-step guidelines for waste categorization, collection, transportation, and treatment processes.

III. MAJOR DIFFERENCES BETWEEN BWM RULES 1998 AND 2016.

Table 6: Difference in 1998 and 2016 BWM rules.

S. No.	1998	2016
1.	Authorization is necessary for occupiers who have a bed capacity exceeding 1000.	Authorization must be obtained by every occupier who generates Biomedical Waste, including health camps or Ayush facilities.
2.	Operator responsibilities are lacking.	The operator's responsibilities are outlined.
3.	Biomedical waste is categorized into ten distinct groups.	Biomedical waste is categorized into four distinct groups.
4.	The regulations apply exclusively to Healthcare Establishments (HCEs) with a bed capacity exceeding 1000.	All Healthcare Establishments (HCEs) are required to comply with the mandatory treatment and disposal regulations for Biomedical waste.
5.	An established format for the annual report is not available.	A format for the annual report is included as an attachment with the rules.
6.	Schedule I, II, III, VI, V.	Change of schedule I, II, III, VI.

IV. LEGISLATION PERTAINING TO THE MANAGEMENT OF BIOMEDICAL WASTE.

The relevant central legislations concerning the management of biomedical waste in India encompass [4]:

- The Environment (Protection) Act, 1986.
- The Hazardous Waste (Management and Handling) Rules, 1998
- The Biomedical Waste (Management and Handling) Rules, 1998 [2].
- Amendments to the Biomedical Waste (Management and Handling) Rules, 2000 and 2003.
- The Bio-medical Waste (Management and Handling) Rules, 2016.

It's important to note that individuals are authorized to outline any suspected carelessness in the management and controlling of biomedical waste to the relevant authorities.

V. FUTURE WORK

Enhanced Training and Education: Execute thorough training initiatives focus at education healthcare professionals, waste handlers, and the common public concerning accurate waste separation, handling and disposal methods.

Investment in Infrastructure: Allocate resources to set up and enlarge Common Biomedical Waste Treatment Facilities to label the current loss in waste handling capacity.

Enhancement of Record-Keeping Mechanisms: Implement digital tracking systems that supervise and find the journey of biomedical waste from its formation to final disposal, assuring transparency and accountability.

Engagement with Local Communities: Involve local communities in waste management enterprises, encouraging their working involvement in waste depletion campaigns and prompt reporting of any issues.

Promotion of Ongoing Research: Promote constant research to explore safer, cost-effective, and sustainable waste management results, continuously enhancing industry practices.

VI. CONCLUSION

The paper's conclusion highlights the key aspects of biomedical waste management as follows:

- Involve cooperation between various stakeholders.
- Collaboration among healthcare facilities, government bodies, and professionals is crucial.
- Strong dedication from authorities is necessary for effective BMWM.
- Government should ensure the implementation of proper waste management practices.
- Healthcare workers and facilities must follow recommended waste management practices.
- Continuous assessment of BMWM practices is necessary.
- Focus on improving waste segregation, transportation, and disposal methods.

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