"DIALOG

VOL #05 ISSUE #10

WASTE MANAGEMENT IN HEALTHCARE FACILITIES

originates from diverse healthcare activities, ranging from patient care to diagnostic procedures.

EFFECTIVE MANAGEMENT

within healthcare facilities is paramount to prevent health hazards.

FEATURE

How Bio-medical Waste Management Initiatives Started in India?

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CURATORS MESSAGE

Welcome to a comprehensive exploration of Biomedical Waste Management (BMW) within the Indian healthcare system. This curated collection of articles stands as a testament to the collective wisdom and expertise of our esteemed contributors, each shedding profound light on various dimensions of waste management. The articles contained herein serve as a guidebook, navigating through the intricate tapestry of BMW practices, regulations, and innovative solutions.

Starting with an insightful overview by Ms. Anu Agrawal and traversing through the historical genesis elucidated by Dr. Vijay Agarwal, we delve deeper into the regulatory frameworks and meticulous guidelines outlined by experts such as Dr. Deepthi Madhu. Dr. Aruna Poojary's exploration of color coding and Mr. A K Nathan's discourse on transportation and treatment act as guiding beacons, emphasizing the meticulous steps integral to proper waste segregation and management. Further into the collection, Mr. Vinod Kumar KB and Dhanya Michael illuminate the complexities of liquid waste and e-waste disposal in healthcare settings. From the concept of transforming waste into wellness, beautifully articulated by Ms. Vidya Mani, to pragmatic approaches suggested by Ms. Margaret on reducing, reusing, and recycling within healthcare setups, this collection embodies a holistic perspective. Moreover, Maj (Dr) Jyothsna Venkatesh's examination of infection control and environmental impact, Sophia Lawrence Vijayananthan's insights on preventing needlestick injuries, and Dr. V R Yamunadevi's exploration of disposal challenges in a common biomedical waste management facility, paint a comprehensive canvas of challenges and strategies in the realm of BMW. Dr. Arcy Billoria's emphasis on community engagement and Dr. Malathi M's illumination of the Internet of Things (IoT) applications in waste management further enhance the depth of this collection. Finally, the collaborative article by multiple experts offers a panoramic view, touching upon challenges, innovations, and collaborative solutions. These articles, collectively, offer a treasure trove of information and guidance, aiming not just to inform but to inspire action and collaboration. They serve as a clarion call to unite efforts, foster innovations, and drive transformative change for a healthier, sustainable future within the healthcare sector.

We hope these insights ignite conversations, spark innovative ideas, and foster collaborative endeavours towards a cleaner, safer, and more sustainable healthcare environment.

"Persistent challenges highlight the crucial necessity of clarifying how storage regulations are understood and determining the most suitable containers for hazardous waste, emphasizing the urgency for better interpretation and optimal choices in waste management practices."

Waste Management: The Indian Scenario

Abstract

The management of biomedical waste in India has undergone significant transformation over the years due to increasing concerns regarding its detrimental effects on public health and the environment. This historical overview delineates the evolution of biomedical waste management, from the nascent stages during the 1970s-1980s to the formulation of the Bio- Medical Waste (Management and Handling) Rules in 1998. Subsequent amendments and milestones in 2005, 2011, and 2016 marked pivotal moments, emphasizing the need for stringent guidelines, technological advancements, and public awareness campaigns. The current scenario underscores India's stringent regulations for biomedical waste management, accentuating technological integration and public education to foster responsible waste handling practices. Technical guidelines have been established to address specific aspects, such as waste generated during COVID-19 treatment, environmental compensation, and verification protocols for waste treatment facilities. The imperative for effective biomedical waste management becomes apparent considering that only a fraction of hospital waste is categorized as hazardous, yet a significant gap exists in basic healthcare waste management across least developed countries. The healthcare sector substantial carbon footprint necessitates a transition towards sustainable waste management practices to mitigate environmental impact. However, challenges persist, notably regarding the interpretation of storage rules and the choice of containers for hazardous waste. Debates continue between resource utilization, infection control, and sustainability.

Additionally, spill management protocols remain critical, requiring adherence to stringent disinfection procedures to contain and eliminate hazardous spills effectively.

In essence, while India has made substantial strides in biomedical waste management, challenges in interpretation, implementation, and compliance demand continued attention. Harmonizing regulations, enhancing infrastructure, and fostering sustainable waste management practices are pivotal for ensuring a safe and environmentally conscious healthcare system.

History of Biomedical Waste

The management of biomedical waste in India has evolved significantly over time due to growing concerns about its impact on public health and the environment. Here an overview of its history:

Early Years

Late 1980s: Incidents like the Bhopal Gas Tragedy in 1984 raised awareness about the hazardous impact of improper waste disposal.

Regulatory Framework: Bio-Medical Waste (Management and Handling) Rules, 1998: India introduced its first official guidelines for biomedical waste management.

These rules aimed to regulate the handling, treatment, and disposal of biomedical waste to minimize health and environmental risks.

Amendments

Over the years, amendments were made to these rules, such as the Biomedical Waste (Management and Handling) Amendment Rules in 2003 and subsequent revisions to enhance and strengthen the guidelines.

Key Milestones

- The introduction of colour-coded segregation and guidelines for waste segregation at the source was a significant development.

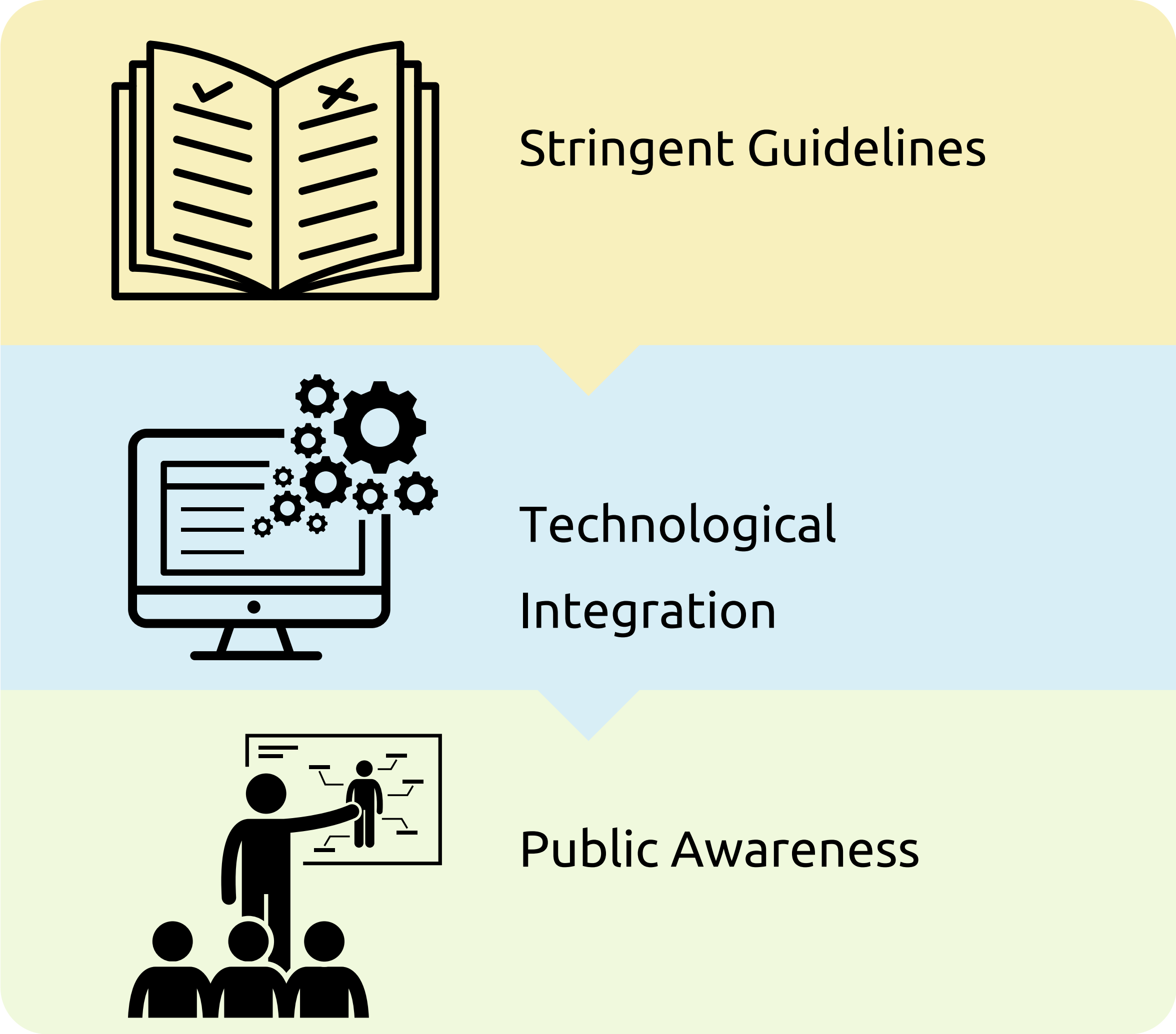
- Further amendments emphasized the need for training, awareness programs.

Current Scenario

- Stringent Guidelines: India currently has stringent rules for biomedical waste management, focusing on segregation, collection, treatment, and safe disposal.

- Technological Integration: With advancements in technology, the emphasis is on innovative methods for waste treatment and disposal to reduce environmental impact.

- Public Awareness: Efforts are ongoing to raise awareness among healthcare personnel, waste handlers, and the public about proper waste management practices.



Stringent Guidelines

Technological Integration

Public Awareness

Technical guidelines

- Revision 5: Guidelines for handling treatment and disposal of waste generated during treatment, diagnostics and quarantine of COVID-19 patients.
- Guidelines for monitoring performance of CBWTFs by SPCBs/PCCs
- Revision 4: Guidelines for handling, treatment and disposal of waste generated during treatment, diagnostics and quarantine of COVID-19 patients.
- Advisory related to service of common biomedical waste treatment facilities to states
- Toolkit for biomedical waste management rules, 2016
- Guidelines for imposition of environmental compensation against HCFs and CBWTFs
- Guidelines for verification of two seconds residence time in secondary combustion chamber of the biomedical waste incinerator
- Guidelines for management of healthcare waste in healthcare facilities as per biomedical waste management rules, 2016

- Guidelines on the management of BMW generated during UIP
- Environmentally sound management of mercury waste generated from healthcare facilities

The need for biomedical waste management

- According to the WHO only about 15% of hospital waste falls into the hazardous category.
- Yet a joint study by WHO and UNICEF found that only one in three HCFs in least developed countries have basic Health care waste management (HCWM).

Moving towards sustainability

- The health care sector is leading climate polluter, with healthcare's climate footprint increasing from 4.4% of net global emissions in 2014 to 5.2% in 2019. Without action, healthcare emission could triple by 2050
- Minimum impact waste management-environment friendly waste treatment and disposal, yellow bag waste reduction, waste reduction and recycling, pharmaceutical and toxic chemical waste management, environmentally preferable purchasing etc.
- A 700 bedded hospital managing its waste wisely can reduce its carbon footprint by 1300MTCO2/y
- Indian medical sector would end up saving-272, 132MTCO2E emission in the environment, by recycling its plastic rather than incinerating it (2013).

Confusion on 48hour storage rule

- Most of the people are still following the 48h clause for the disposal of all BMW, as was mentioned in the 1998 rule i.e. ((5) No untreated bio-medical waste shall be kept stored beyond a period of 48hours).
- But in the 2016 rule, the clause was changed and only a few categories were put under this clause. (BMW rule 2016, say- (7) untreated human anatomical waste, animal anatomical waste, soiled waste and biotechnology waste shall not be stored beyond a period of 48hours)
- This was done to avoid wasteful disposal of sharps waste containers and container for glass waste.

Container for Sharps

- Most of the HCFs were using plastic cans in the hospitals as PPC
- Auditors expect use of proper white virgin PPCs
- Debate between resources utilization and sustainability Vs infection control

Spill Management protocol

Clean and disinfect VS Disinfect and clean

As per spill management protocol-CDC, WHO

- Wear appropriate PPE
- Confine the spill and wipe it up immediately with absorbent (paper) towels, cloths, or absorbent granules, and dispose as infectious waste.
- Clean thoroughly, using neutral detergent and warm water solution

- Disinfect by using facility-approved intermediate-level disinfectant. Typically, chlorine-based disinfectant at (1:100 or 1:10 dilution of 5% chlorine-bleach; depending on the size of the spill) are adequate. Moreover, it allows the disinfectant to remain on the surface for the required contact time (e.g., 10mins), and then rinse the area with clean water to remove the disinfectant residue (if required).

Other facts for spill management

For spill containing large amounts of blood or other body substances, workers should first remove visible organic matter with absorbent material (e.g disposable paper towels discarded into leak-proof, properly labelled containment) and then clean and decontaminate the area.

A recent study demonstrated that even strong chlorine solution (i.e., 1:10 dilution of chlorine bleach) may fail to totally inactivate high titers of virus in large quantities of blood, but in the absence of blood these disinfectants can achieve complete viral inactivation. this evidence supports the need to remove most organic matter from a large spill before final disinfection of the surface.

Challenges and Future Outlook

1. Challenges persist, including ensuring compliance, infrastructure gaps, and monitoring practices across the country.
2. Future strategies involve strengthening enforcement mechanisms, enhancing infrastructure, promoting research and innovation in waste management technologies, and continuous awareness programs.

Overall, India has made significant strides in addressing biomedical waste management, but ongoing efforts are essential to ensure effective implementation and compliance across all sectors involved in generating biomedical waste.

Conclusion

In conclusion, India’s trajectory in managing biomedical waste reflects an evolving commitment to public health and environmental welfare. The historical progression from initial guidelines to the present stringent regulations demonstrates the nations endeavor to address the complexities of waste management in healthcare settings. However, despite the advancements and robust guidelines, challenges persist. Clarification and uniform interpretation of storage rules, sustainable container choices, and effective spill management protocols remain areas requiring attention and resolution. The imperative need to bridge the gap between guidelines and implementation is evident, emphasizing the importance of enhanced infrastructure, standardized practices, and continual education and awareness programs. Moving forward, a collaborative effort among regulatory bodies, healthcare institutions, and stakeholders is crucial to foster sustainable biomedical waste management practices. Aligning policies with practical application, harnessing technological innovations, and fostering a culture of environmental responsibility will be pivotal in ensuring a safe, sustainable, and environmentally conscious healthcare ecosystem in India.

Global History

During 1987–88, an environmental crisis known as the "syringe tide" struck Connecticut, New Jersey, and New York, causing extensive medical waste and raw garbage, including hypodermic syringes, to wash up on the Jersey Shore, New York City, and Long Island beaches. This led to beach closures along the Atlantic coast, exacerbating concerns amid the HIV/AIDS epidemic of the 1980s.

Responding to these events, participants of the New Jersey Harbor Estuary Program (HEP) enacted the Short-term Floatables Action Plan in 1989. This successful plan aimed to reduce debris wash-ups by intercepting debris slicks within the Harbor. Its key components include regular environmental patrols to spot debris slicks, cleanup efforts led by the United States Army Corps of Engineers (USACE) targeting potential slick occurrences, additional cleanup actions when new slicks are identified, and a coordinated communication network overseen by the United States Environmental Protection Agency to manage reporting and cleanup operations among program participants.

World Health Organization (WHO) assembly in June 2007, essential principles were established for effective and sustainable healthcare waste management. The inaugural edition of the WHO guidebook, known as "The Blue Book," was released in 1999, with a subsequent 2014 edition incorporating newer methodologies for safe biomedical waste (BMW) disposal, updated pollution control measures, and detection methods.

Three international treaties—the Basel Convention on Hazardous Waste, the Stockholm Convention on Persistent Organic Pollutants (POPs), and the Minamata Convention on Mercury—significantly influence waste management policies due to their relevance in environmental protection and sustainable development. The Basel Convention, encompassing 170 member countries, focuses on safeguarding human health and the environment from hazardous waste, particularly clinical waste generated in healthcare facilities. The Stockholm Convention targets Persistent Organic Pollutants (POPs) such as dioxins and furans, produced by medical waste incineration and threaten living organisms. It guides Best Environmental Practices (BEP), including source reduction, segregation, and resource recovery. The Minamata Convention, established in 2014, addresses the adverse impact of mercury on human health and the environment. This treaty involves phasing out mercury-containing medical items like thermometers and blood pressure devices from healthcare services.

A 2012 WHO survey evaluated the healthcare waste management status in 24 West Pacific countries, highlighting satisfactory performance in management, training, and policy aspects except for Micronesia, Nauru, and Kiribati. While Japan and the Republic of Korea implement Best Available Technologies (BAT) for BMW logistics and treatment, many countries face financial constraints hindering effective healthcare waste management. In Canada, variations in medical waste management practices exist among provinces, lacking uniform regulations. Hospitals in Canada are transitioning from on-site incineration to centralized provincial facilities for BMW sterilization, showcasing evolving waste management strategies.

Biomedical Waste Management in India: The Evolution from Judicial Intervention to Sustainable Practices

Dr Vijay Agarwal
President, CAHO

Introduction

Biomedical Waste (BMW) management in India has transitioned from an overlooked issue to a domain of structured and sustainable practices, largely driven by judicial activism and evolving legal frameworks. Initially the Environmental Protection Act, 1986, and Hazardous Wastes (Management and Handling) Rules, 1989 did not cover Bio Medical Waste. The focus on bio medical waste disposal came from the judiciary, particularly through the landmark judgment of Dr. B.L. Wadhera Vs Union of India.

The Wake-Up Call: Dr. B.L. Wadhera Vs Union of India

In 1995, the case brought the neglected issue of BMW to light, emphasizing the government oversight in not categorizing it as hazardous waste. The Supreme Court directives for incinerator installation and improved waste management practices in Delhi served as a wake- up call. The court emphasised upon the responsibility to dispose of the waste upon the producers (hospitals) and ruled that all hospitals >50 beds must install incinerators. This legal judgement not only exposed the regulatory gaps but also set in motion the formulation of the Biomedical Waste (Management and Handling) Rules in 1998, marking the beginning of a specialized focus on BMW.

The Criticism and the Shift

The Supreme Court directives, while well-intentioned, were met with criticism due to the environmental and health concerns associated with incineration.

Court Case and Judgement

The pushback from environmentalists and health experts like Mr. Ravi Agarwal (Director Toxic Links) and Dr Vijay Agarwal (The then Chairman Nursing Home Forum of Delhi Medical Association) led to a judicial reassessment. This criticism was instrumental in shifting the focus from merely disposing of waste by incineration to considering the environmental and health implications of disposal methods, leading to more sustainable approaches in BMW management. Widespread incineration was linked to production of Dioxins and Furans which are known carcinogens.

The Emergence of Centralized Waste Management Facilities

The revised judicial stance encouraged the development of Centralized Waste Management Facilities, a concept that revolutionized BMW disposal. These facilities offered a more eco-friendly, efficient, and controlled approach, marking a significant departure from the earlier, more haphazard practices. The model, initiated in the National Capital Region, became a blueprint for nationwide BMW management strategies.

Implementations and Amendments

The implementation of the Biomedical Waste (Management and Handling) Rules represented a paradigm shift. Subsequent amendments in 2000 and 2016 further refined these rules, ensuring they remained relevant with the advancing technologies and more effective management strategies. These changes illustrate the dynamic nature of legal frameworks adapting to new challenges and innovations in waste management.

Role of CPCB and SPCBs

The Central Pollution Control Board and State Pollution Control Boards emerged as vigilant overseers of BMW management. Their role expanded from mere regulatory bodies to active enforcers of compliance, with a significant focus on regular inspections, authorizations, and penalizing non-compliance. Their evolving function reflects the growing seriousness and sophistication in BMW regulation.

Future Aspects

The future of BMW management in India is geared towards increasing the awareness and capacity of healthcare providers. Educational programs, technological advancements, and collaborative efforts between various stakeholders are becoming increasingly significant. These initiatives are crucial for embedding sustainable waste management practices within the healthcare sector’s ethos.

Conclusion

The evolution of BMW management in India from judicial intervention to sustainable practices is a testament to the power of legal impetus and collective effort. The journey from ignorance to awareness and then to action highlights a significant shift in understanding and addressing the complexities of BMW. It reflects a broader commitment to public health, environmental protection, and the sustainable development goals.

The proactive role of the judiciary, coupled with the responsive legislative amendments and the increasing involvement of environmental and health activists, has been instrumental in shaping a more responsible approach to BMW management in India.

> **Preserving health, preserving Earth: India's commitment to waste stewardship.**

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Within the comprehensive framework of biomedical waste management rules, compliance isn't just a choice—it's the shield safeguarding public health and our environment

Regulatory framework of biomedical waste management in India

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Infection control officer,
Cartias hospital, Kottayam,
Kerala

Abstract

The article explores the comprehensive regulatory framework governing biomedical waste management in India, primarily anchored by the Biomedical Waste Management Rules, 2016. It delves into the guidelines designed to ensure safe handling, treatment, and disposal of biomedical waste to mitigate health and environmental risks. The framework encompasses guidelines for waste segregation, collection, treatment, and disposal, emphasizing compliance and stringent measures to protect public health and the environment. Additionally, the piece outlines significant amendments, highlights key differences between earlier rules, and addresses the penalties associated with non-compliance.

Introduction

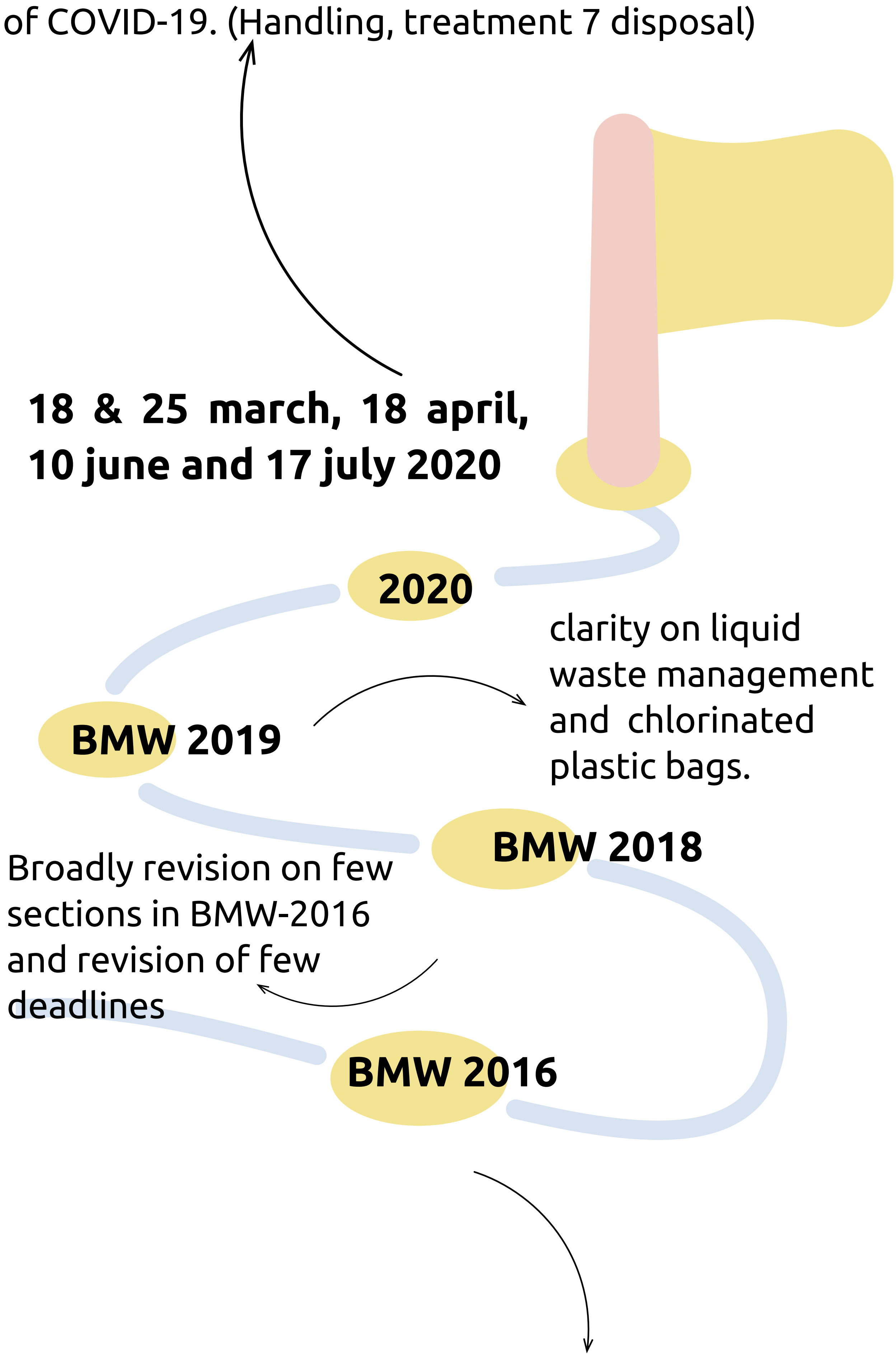
The regulatory framework governing biomedical waste management in India is a structured set of guidelines and rules designed to ensure safe and systematic handling, treatment, and disposal of biomedical waste. These regulations aim to mitigate health and environmental risks posed by medical waste generated in healthcare facilities. Governed primarily by the Biomedical Waste Management Rules, 2016, these guidelines delineate procedures for waste segregation, collection, treatment, and disposal. The framework establishes protocols for waste categories, color-coded segregation, and the responsibilities of healthcare facilities, emphasizing compliance and stringent measures to protect public health and the environment.

BMW rules comes under?

1. Ministry of health and family welfare
2. Ministry of environment, forest & climate change
3. Ministry of resources
4. Ministry of water resources.

BMW Milestones

Guidelines for management of waste generated during diagnostics, treatment and quarantine of COVID-19. (Handling, treatment 7 disposal)



18 & 25 march, 18 april, 10 june and 17 july 2020

2020

clarity on liquid waste management and chlorinated plastic bags.

BMW 2019

BMW 2018

Broadly revision on few sections in BMW-2016 and revision of few deadlines

BMW 2016

Launch of biomedical waste management rules- by ministry of environment, forest and climate change- march 2016

Uniform guidelines and code of practice for managing BMW

1. Hospitals, nursing homes, clinics, dispensaries
2. Veterinary institutions, animal houses
3. Pathological laboratories, blood banks
4. Ayush hospitals, Clinical establishments
5. Research or educational institutions
6. Health camps, medical or surgical camps, vaccination camps, blood donation camps
7. First aid rooms of schools
8. Forensic laboratories and research labs

BMW rules

Remember that the BMW rules of 2016 do not apply to:

1. Radioactive waste, Atomic Energy Act, 1987

The management of radioactive waste in India is regulated by the Atomic Energy Act of 1962, which was amended in 1987. The Act aims to regulate the development, control, and use of atomic energy. It sets the guidelines and provisions for the safe handling, storage, transportation, and disposal of radioactive materials and waste generated from nuclear facilities, medical institutions, and industrial applications. The 1987 amendment specifically addresses safety measures, licensing, and penalties associated with the misuse or mishandling of radioactive substances. This legislation ensures that activities related to atomic energy comply with stringent safety protocols to protect public health and the environment from potential hazards associated with radioactive waste.

2. Hazardous chemical rules, 1989

The Hazardous Chemical Rules of 1989 in India are legislative guidelines formulated under the Environment Protection Act of 1986. These rules were established to regulate and manage hazardous chemicals, ensuring their safe handling, transport, storage, and disposal. The rules aim to prevent and reduce the risks posed by hazardous chemicals to human health and the environment. They outline stringent measures for the identification, categorization, labelling, packaging, and transportation of such substances. Additionally, these rules mandate the creation of safety data sheets (SDS) and emergency response plans for hazardous chemical-related incidents, emphasizing the importance of employee training and public awareness regarding these materials& and potential risks. The Hazardous Chemical Rules play a pivotal role in minimizing hazards associated with the use and management of dangerous chemicals across various industrial sectors.

3. Solid wastes covered under MSW, rule, 2000

The Municipal Solid Wastes (Management and Handling) Rules, 2000 in India encompass various types of solid waste generated across different sectors. It covers biodegradable waste, comprising organic materials like kitchen waste, garden residue, and biodegradable packaging. Non-biodegradable waste, including plastics, metals, glass, and rubber, is also regulated under these rules. Additionally, it addresses domestic hazardous waste such as used batteries, paints, e-waste, and discarded medicines.

Construction and demolition waste, bulk waste like furniture and appliances, and healthcare waste from medical facilities, including biomedical waste, are among the categories managed through these regulations. The rules aim to streamline the segregation, collection, and appropriate disposal of these solid wastes to promote environmentally sustainable waste management practices.

4. Lead-acid batteries, batteries rule, 2001

The Batteries (Management and Handling) Rules, 2001 in India govern the management of lead acid batteries and other types of batteries to mitigate environmental hazards associated with their disposal. Lead acid batteries, commonly used in automobiles and industrial applications, fall under these regulations due to their potential environmental impact from lead and acid content. The rules specify guidelines for the collection, recycling, and safe disposal of used batteries. They aim to ensure proper handling to prevent soil and water contamination caused by lead leaching and acid spillage from discarded batteries. These rules enforce responsibilities on battery manufacturers, dealers, and consumers to facilitate the safe disposal and recycling of lead-acid batteries, minimizing their adverse effects on the environment.

5. Hazardous waste management handling & transboundary movement rules, 2008.

The Hazardous Waste (Management, Handling, and Transboundary Movement) Rules of 2008 in India are designed to regulate and manage hazardous waste to prevent adverse effects on human health and the environment. These rules provide a comprehensive framework for the proper handling, treatment, storage, and disposal of hazardous waste. They specify guidelines for the identification, categorization, and classification of hazardous waste, along with measures for its safe transportation and transboundary movement. The regulations outline responsibilities for generators, transporters, and operators of facilities dealing with hazardous waste to ensure compliance with safety standards and environmental protection. Additionally, the rules emphasize the establishment of treatment, storage, and disposal facilities for the effective management of hazardous waste and the implementation of environmentally sound practices throughout its lifecycle.

6. E-waste, E-waste rules, 2011

The E-Waste (Management and Handling) Rules of 2011 in India aim to address the growing environmental and health concerns associated with electronic waste (e-waste). These rules provide a regulatory framework for the proper management, handling, and disposal of e-waste to minimize its impact on the environment and human health. The guidelines focus on the safe dismantling and recycling of electronic products, including obsolete or end-of-life electrical and electronic equipment. The rules prescribe procedures for the collection, storage, transportation, and treatment of e-waste, emphasizing the need for authorized dismantlers and recyclers. Additionally, the E-Waste Rules promote awareness and establish responsibilities for manufacturers, consumers, and other stakeholders in the e-waste management chain.

The overarching goal is to encourage sustainable practices, resource recovery, and the reduction of adverse effects associated with the disposal of electronic waste.

7. Hazardous micro-organisms rules, 1989

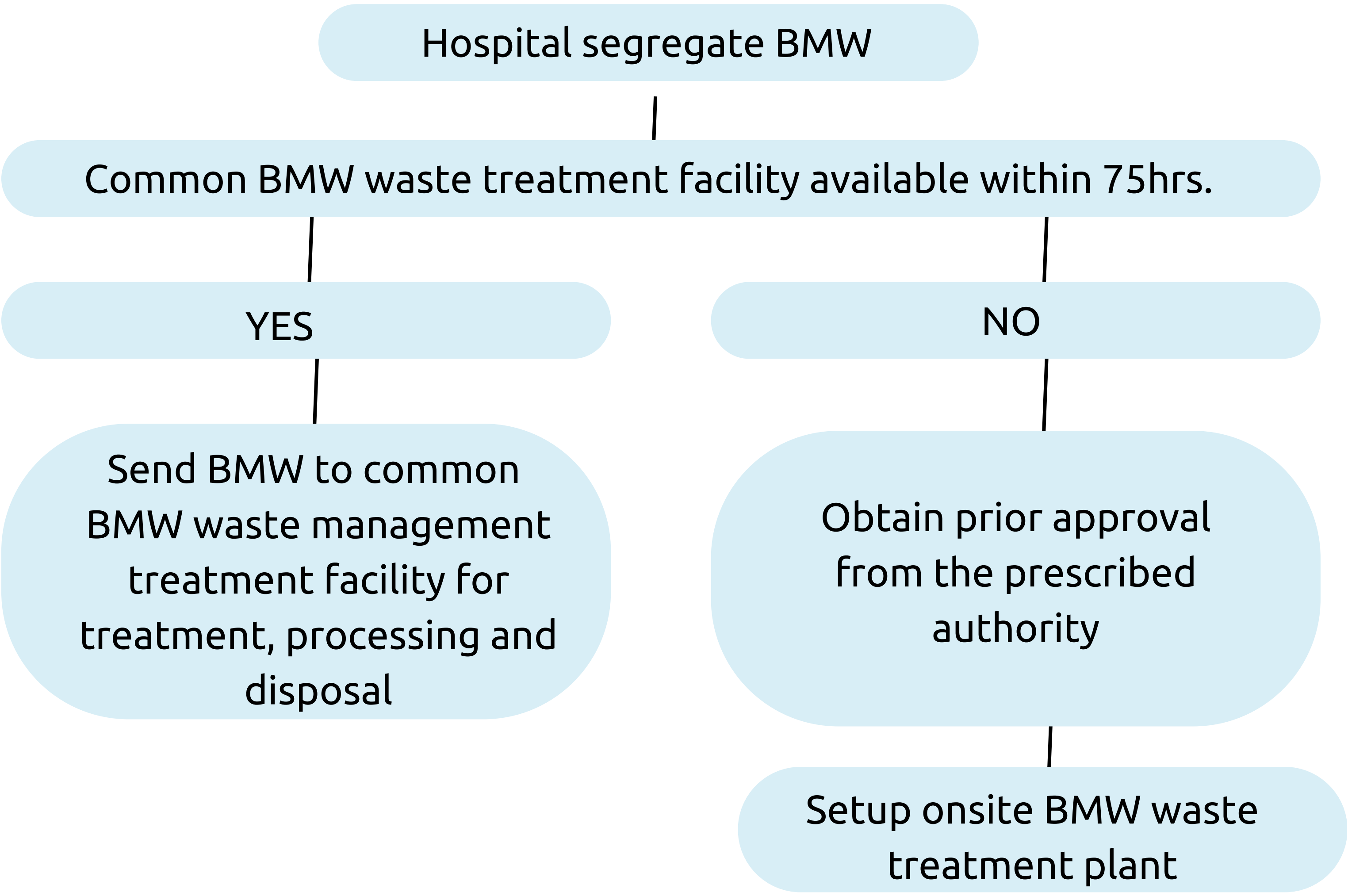
The Hazardous Micro-organisms Rules of 1989 in India were established to regulate and ensure safety in handling microorganisms that have the potential to cause diseases in humans, animals, or plants. These rules focus on containment, handling, and disposal of hazardous microorganisms to prevent their accidental release into the environment. The guidelines outline safety measures, including protocols for handling and transporting these microorganisms, safety practices in laboratories, and the requirement of appropriate containment facilities to prevent the spread of such organisms. Additionally, these rules highlight the importance of reporting and managing incidents involving hazardous microorganisms to mitigate potential risks to public health and the environment.

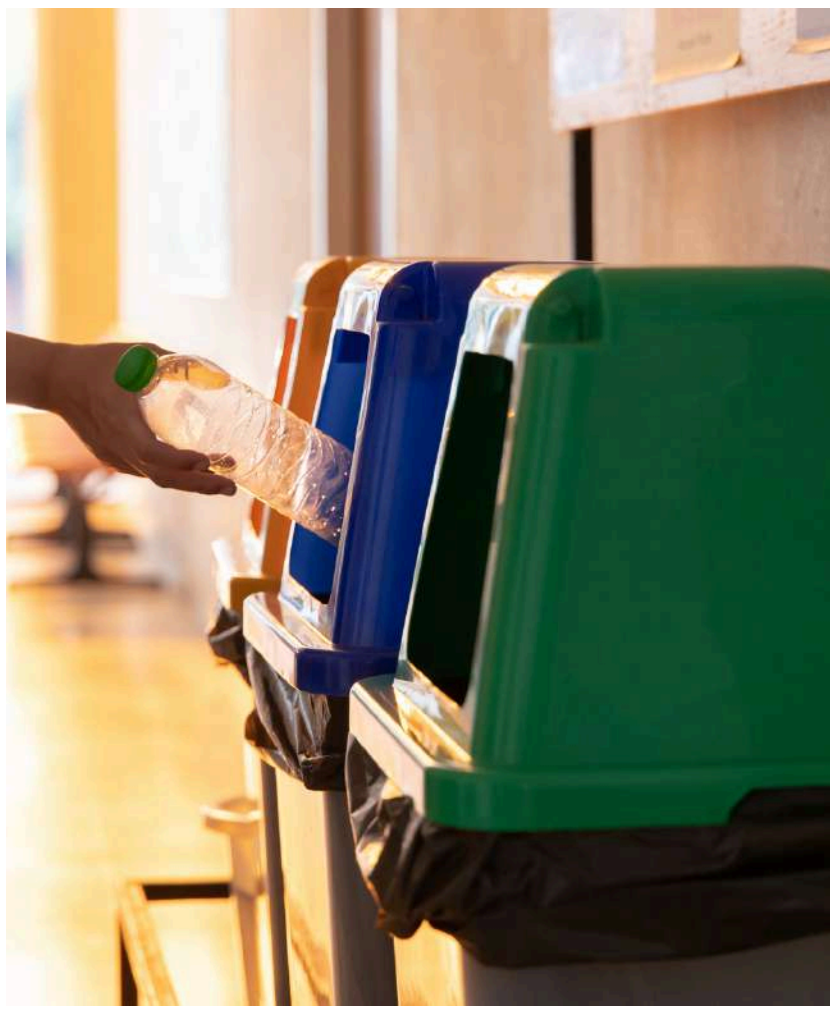
Statutory requirements

The health care organization possess a NOC from state Pollution control board (PCB) for generating, storage and disposal of BMW.

BMW-2016 rule defines

1. **Occupier:** Administrator of the health care facility.
2. **Operator:** Runs the common treatment facility
3. **Prescribed authority:** The state pollution control board in respect of a state and pollution.
4. **Control Committee:** Respect of a union territory.





Note: Occupier or the administrator of the healthcare facility and the operator or the person who runs the common treatment facility should maintain records of recyclable wastes.

Salient features of amended BMW rules 2016

1. Pre-treat laboratory, microbiological, blood samples and blood bags through disinfection or sterilization on site.
2. Phase out the use of chlorinated plastic bags, gloves and blood bags within two years.
3. Provides training to all its healthcare workers and immunizes all health workers regularly.
4. Established a barcode system for bags or containers containing bio-medical waste for disposal.
5. Bio-medical waste has been classified into 4 categories instead of 10 to improve the segregation of waste at source.
6. No occupier shall establish a site treatment and disposal facility if services of a common biomedical waste treatment facility are available at a distance of seventy-five kilometres.
7. Operator of a common biomedical waste treatment and disposal facility to ensure the timely collection (within 48 hours) of biomedical waste from the HCFs and assist the HCFs in the conduct of training.
8. Annual report to be submitted in prescribed format on or before June 30 of every year.

Major accidents and its reporting

Report major accidents:

- While handling of bio-medical waste having potential to affect large masses of public and include toppling of the truck carrying bio-medical waste, release of bio-medical waste in any water body.
- Accidents caused by fire hazards, blasts during handling of biomedical waste the remedial action taken and the records relevant thereto, (including nil report) in form I to the prescribed authority and also along with the annual report.
- Exclude accidents like needle pick injuries, and mercury spills.

Major differences between BMW rules 1998 and 2016

1998	2016
Occupiers with >1000 beds require to obtain authorization	Every occupier generating BMW including health camp or AYUSH require to obtain authorization
Operator duties absent	Duties of operator listed
BMW divided in 10 categories	BMW divided into 4 categories
Rules restricted to HCE with >1000beds	BMW treatment and disposal mandatory for all HCEs
No format for annual report	A format for annual report appended with the rules
Schedule I, II, III, IV and V	Change of schedule I, II, III & IV

Need for QR code system

1. Tracking of BMW
2. Daily check on Occupier & CBWTF
3. Preventing pilferage of BMW at Occupier and CBWTF
4. Identification of source of generation of BMW in case of improver disposal.

BMW rules amendment rules 2018

- Municipal waste handling should be substituted with solid waste management guidelines 2016.
- Hazardous waste (Management, Handling and transboundary Movement) Rules, 2008 should be substituted with hazardous and other wastes (Management and transboundary movement) rule, 2016.
- E-waste (Management and handling) rule, 2011- substitute with e-waste (Management) rules, 2016.
- All the healthcare facilites (any number of beds) shall make available the annual report on its website within a period of two years from the date of publication of bio-medical waste management (amendment) rule, 2018.

Against the category blue

Substitute blue coloured card boxes with puncture proof and leak proof boxes or containers with blue colored marking.

BMW rules amendment rules 2019 (19th feb 2019)

1. The occupier of all bedded health care unit, shall maintain and update on a day to day basis the biomedical waste management register.
2. All bedded healthcare units shall display the monthly record of waste disposal management on its website.
3. Such health care facilities (irrespective of any number of beds), shall make the annual report available on its website before 19th march 2021.
4. Health care facilities having less than ten beds shall have to comply with the output discharge standard for liquid waste by 31 December, 2019.

uidelines for handling, treatment and disposal of waste generated during treatment / diagnosis / quarantine of COVID-19 patients. Version -5, 26th April, 2022

Penalty for non-complying healthcare facilities

Penalty under the environment protection act, 1986

As per sec-15, sub-section-1

As per section-15, sub-section-2

Under Section 15, Sub-sections 1 and 2 of the Environment Protection Act, 1986, penalties are stipulated for violations of the Act's provisions

Sub-section 1 outlines penalties for non-compliance with the Act or its regulations, stating that contravention of any provision will result in a fine extending to Rs. 1,00,000 or imprisonment for a term not exceeding five years or both. Sub-section 2 specifies that if the offense continues after the initial conviction, an additional fine may be imposed for each day the offense persists, and this penalty may extend to Rs. 5,000 for every day during which the contravention continues after the first conviction.

Environment compensation As per Hon'ble NGT order

The term "environment compensation" refers to the monetary penalty or restitution imposed by the National Green Tribunal (NGT) as per its orders for violations against environmental laws or regulations. This compensation is aimed at mitigating environmental damage caused by an individual, entity, or industry. The NGT often issues directives or orders mandating compensation for environmental violations to deter future infractions and ensure environmental restoration or conservation. The specific amount or nature of compensation is determined by the NGT based on the severity of the violation and the impact on the environment.

Conclusion

The regulatory framework surrounding biomedical waste management in India, anchored by the Biomedical Waste Management Rules, 2016, stands as a robust structure designed to systematically manage medical waste. These guidelines have undergone notable amendments to adapt to changing needs and technology. The rules emphasize stringent compliance, specifying duties for healthcare facilities, operators, and ensuring proper waste segregation, treatment, and disposal. The penalties outlined in the Environment Protection Act, 1986, and the concept of environmental compensation by the National Green Tribunal highlight the seriousness with which environmental violations are viewed. Overall, the framework not only aims to ensure compliance but also prioritizes environmental safety and public health in managing biomedical waste across the country.

Reference

Guideline for healthcare waste as per biomedical waste management rule, 2016.

> "
>
> The amendments and milestones in waste management rules mark pivotal moments in our quest for a healthier environment.

Colour Coding for Segregation of BMW

Dr. Aruna Poojary

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Microbiology, Incharge - Infection Prevention &
Control Breach Candy Hospital Trust
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Abstract

Biomedical Waste Management is a critical process in healthcare facilities aimed at ensuring safe and responsible disposal of waste. This article discusses a comprehensive insight into the crucial steps involved in this process, emphasizing the significance of color coding for the segregation of biomedical waste.

The essential stages of biomedical waste management, starting from segregation at the point of generation, collection, and storage to pre-treatment, transportation, and eventual disposal. It highlights the necessity of compliance with basic tenets of biomedical waste management to guarantee safe handling and containment.

Furthermore, the document provides an in-depth breakdown of the various categories of biomedical waste as per the Biomedical Waste Management Rule, 2016, encompassing the yellow, red, white, and blue categories. Article underscores the importance of following proper segregation, packaging, and pre-treatment protocols for each waste type to ensure effective management.

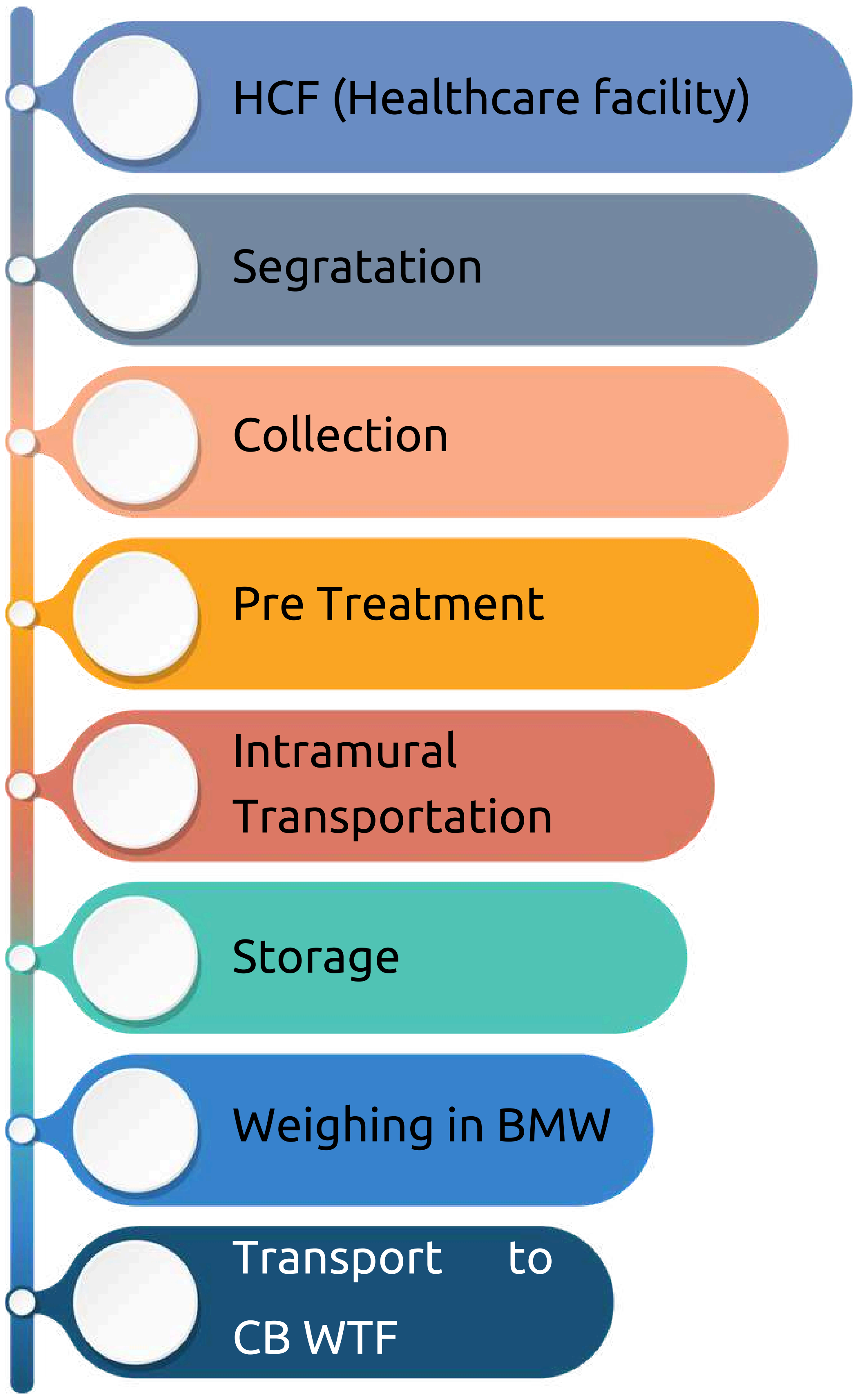
Key considerations and guidelines, such as the treatment standards, dedicated equipment for waste disposal, and suitable disinfection methods, are also elucidated in this comprehensive article.

The expertise and detailed insights serve as a valuable guide for healthcare professionals and facilities navigating the complexities of biomedical waste management.

Introduction

Biomedical waste management is a critical facet of healthcare operations, focusing on the safe and efficient disposal of waste generated in medical facilities. It encompasses a series of meticulous steps, from segregation and collection to treatment and disposal, aimed at minimizing health and environmental hazards associated with biomedical waste. Proper management is essential to ensure compliance with regulations and prevent the spread of infections, safeguarding both public health and the environment.

Steps involved in BMW Management



Biomedical waste management involves several crucial steps to ensure the safe and proper disposal of waste generated in healthcare facilities.

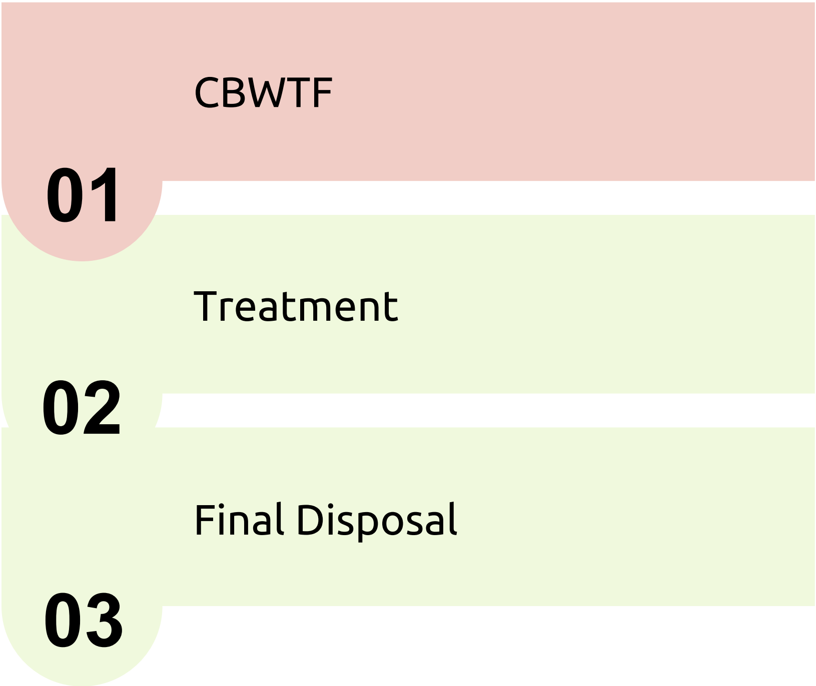
Here are the key steps:

Segregation: The first step is segregating biomedical waste at the point of generation. Waste is categorized into different types (e.g., infectious, sharps, pathological, chemical, etc.) and collected separately using colour-coded containers or bags.

Collection and Storage: Segregated waste is collected in designated containers that comply with safety standards. These containers prevent spillage, leakage, and exposure to waste handlers. The waste is stored temporarily in a secure area before further processing or disposal.

Pre-Treatment: The waste undergoes treatment to minimize its hazardous nature. Common treatment methods include incineration, autoclaving, microwaving, chemical disinfection, and shredding. The goal is to neutralize pathogens and reduce the volume of waste.

Transportation: Collected waste is transported from healthcare facilities to treatment and disposal sites using specialized vehicles. These vehicles adhere to safety regulations to prevent spillage and contamination during transit.



Disposal: After treatment, the waste is safely disposed of following environmentally friendly methods. Disposal options include landfilling for non-hazardous waste, incineration for certain types of waste, and other approved methods based on regulatory guidelines.

Monitoring and Compliance: Continuous monitoring and compliance with regulatory standards are essential. Regular audits, inspections, and assessments ensure that healthcare facilities follow proper waste management protocols.

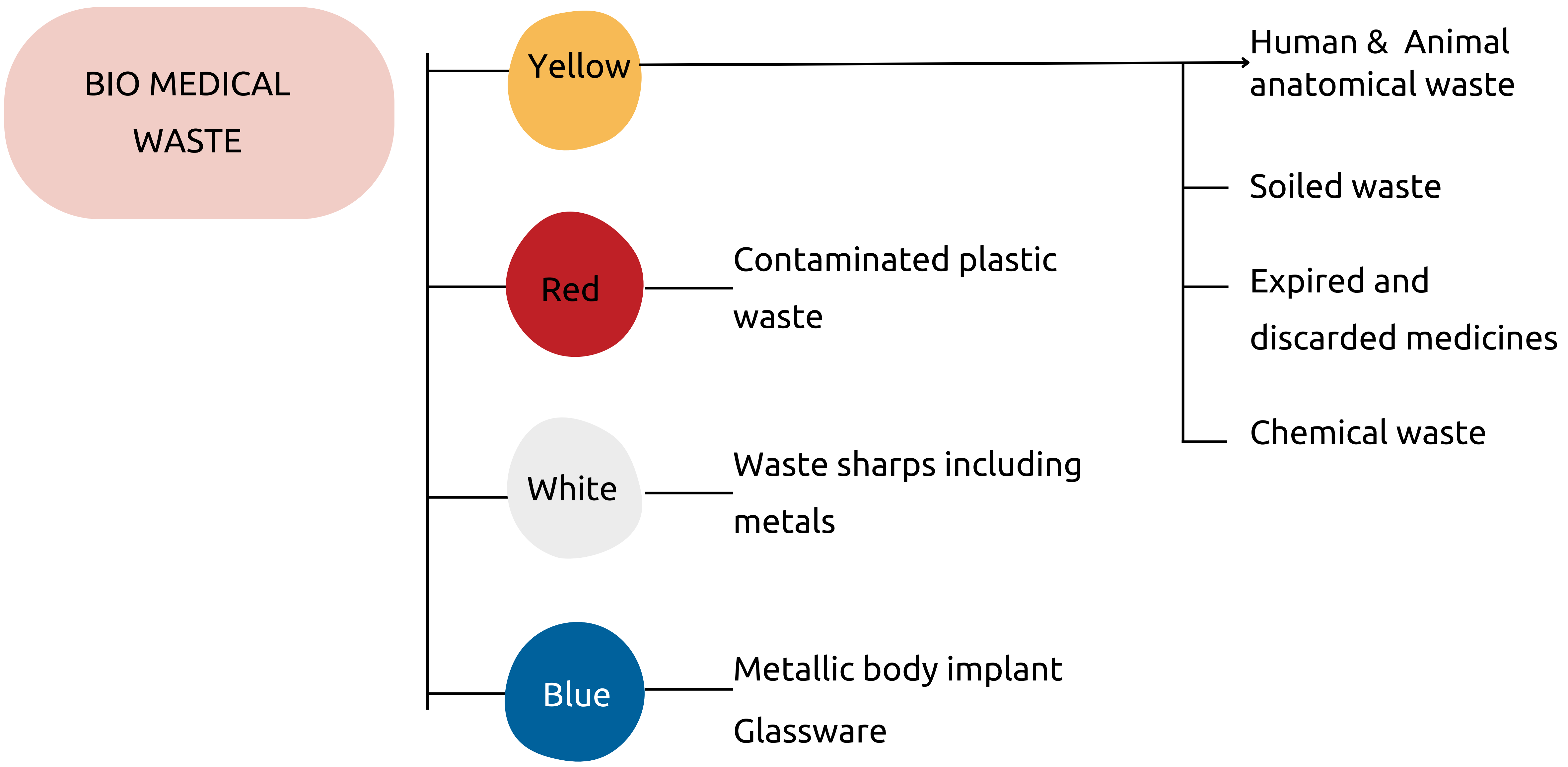
Basic tenets of BMW management

1. Biomedical waste must be segregated at the point of generation of source
2. Biomedical waste bags and sharps containers should be filled to no more than three quarters full.
3. All the bags/containers/bins must be labelled with the symbol of biohazard or cytotoxic hazard.
4. Interim storage-wastes from various departments must be stored in the dirty utility/sections.
5. In house transportation of the waste from the site of generation/interim storage to central waste collection centre (CWC, situated within premises)
6. Must be done in closed trolley
7. Maintained in CWC until final treatment and disposal at CBWTF.

Categories of Biomedical Wastes

According to biomedical waste management rule, 2016, the biomedical wastes fall into four categories:

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



Yellow Category

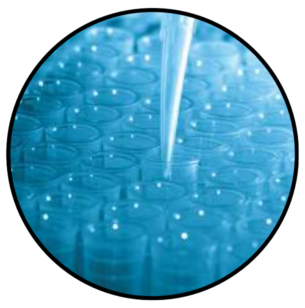
Type of Waste	**Segregation**	**Type of bag**	**Pre-treatment at HCF**
Human anatomical waste	Human tissues, organs, body parts and fetus below the viability period. This includes, placenta and extracted tooth	Yellow non-chlorinated plastic bag	NO
Animal anatomical waster	Animal carcasees, body parts, organs, tissues, animal wastes during experiments or testing in veterinary hospitals or colleges or animal houses hospitals or colleges or animal houses	Yellow non-chlorinated plastic bag	NO

Soiled waste	Items contaminated with blood/body fluids like caps, shoe-cover, gauze, wooden swab stick, paraffin blocks, indicator tapes and disposable masks and gowns	Yellow non-chlorinated plastic bag	NO
Expired and discarded medicines	Antibiotics, cytotoxic drugs, cytotoxic drugs along with their ampules/vials	Yellow non-chlorinated plastic bag	NO
Chemical waste	Chemicals used in production of biological, discarded containers of chemicals and disinfectants	Yellow non-chlorinated plastic bag	NO
Chemical waste	Liquid waste generated due to use of chemicals in production of biological or discarded disinfectants, silver X ray film liquid, discarded formalin, infected secretions, aspirated body fluids, liquid from laboratories and floor washings, cleaning.	Not applicable	Collected through a separate collections system for pre-treatment which comprised of neutralization/precipitation (chemical waste), disinfection (infected waste) Finally goes through the ETP
	Discarded linen, mattresses, bedding contaminated with blood and body fluids	Yellow non-chlorinated plastic bag	NO
	Microbiology, blood bags biotechnology and other clinical laboratory waste, live or attenuated vaccines live or attenuated vaccines	Yellow non-chlorinated plastic bag	Sterilization

Red category

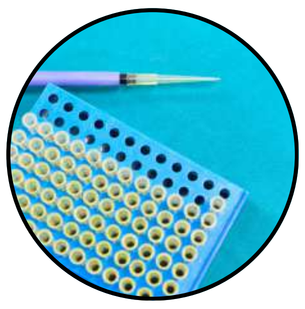
Segregation	**Type of bag**	**Pre-treatment at HCF**
Recyclable waste containing primarily plastic generated from disposable items such as tubing, bottles, intravenous tubes and sets, catheters, urine bags, syringes (without needles and fixed needle syringes with their needles cut), vacutainers and gloves	Red coloured Non-chlorinated plastic bag	Note: Vacutainers with blood samples should be pre-treated and segregated as red category waste.

Viral Transport Media



Pipette Tip

Vacutainer



Testing Kits

Plastic Vial

Goggles

Hazmat suit

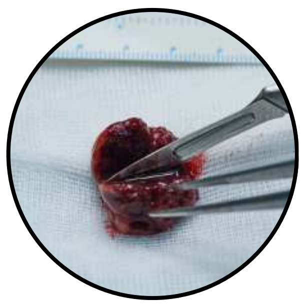
Splash proof plastic cover on

Face shield

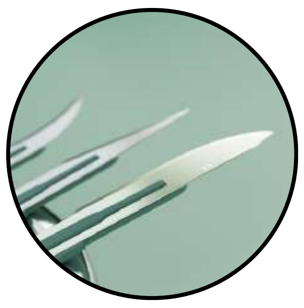
Nitrile gloves

White category

Segregation	Type of bag	Pre-treatment at HCF
Needles, syringes with fixed needles, needles from needles tip cutter or burner, scalpels, blades, or any other contaminated sharp objects. Waste sharps such as lumbar puncture needle, trocar cannula, IABP cannula, arthroscopy blade, insulin pen needle, lancet needle, eye needle, cardioplegia needle and surgical stab knife	White translucent, puncture proof, leakproof, tamper proof container.	No



Sharp blade



Different tyes of needles

Metallic sharp waste

Blue category

Segregation	Type of bag	Pre-treatment at HCF
Glassware: Broken or discarded and contaminated glass, glass slides and glass pipettes including medicine vials and ampoules except those contaminated with cytotoxic wastes	Blue colored puncture proof, leak proof boxed or containers	No
Metallic body implants: Implants used for orthopedic surgeries such as metal sternal wire and orthopedic splints	Blue colored puncture proof, leak proof boxed or containers	No

Glassware and metallic waste ⟶

Blue category bin

Important considerations

1. The treatment of BMW must meet the standards as specified in BMW rule, 2016
2. The autoclave used for sterilization of discard of blood bags, microbiology waste, including vials containing vaccine/positive controls must be dedicated for treatment of bio-medical waste only
3. Chemical disinfections is to be performed by 1% hypochlorite solutions or equivalent disinfectant like aldehydes, lime, ammonium salts, phenolic compounds.
4. Guidelines for management of healthcare wase as per biomedical waste management rule, 2016
5. Pictorial guide on biomedical waste management rule 2016 (amended in 2018 and 2019)

Conclusion

In conclusion, Biomedical Waste Management provides a holistic understanding of the multifaceted process. The comprehensive overview, spanning from segregation to disposal and compliance, underscores the significance of adhering to proper protocols and guidelines. Emphasizing the importance of colour coding for waste segregation and compliance with the Biomedical Waste Management Rule, 2016, this article serves as an invaluable guide for healthcare professionals. The outlining of the critical steps involved in waste management ensures a safer and more efficient handling of biomedical waste in healthcare facilities, promoting a healthier environment and enhanced safety measures.

> Stringent guidelines, technological advancements, and public awareness campaigns pave the way for responsible waste-handling practices.

Transportation and Treatment of BMW

Mr A K Nathan

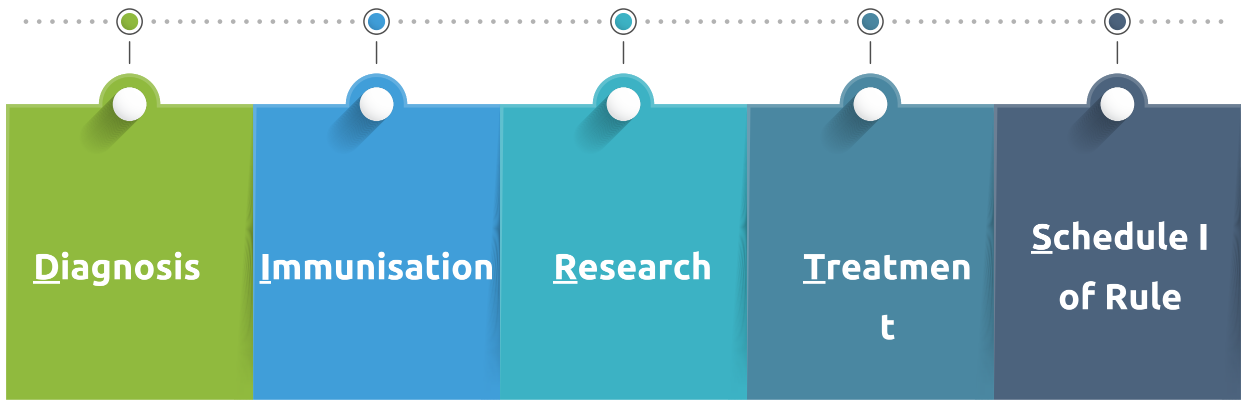
Managing director & CEO,
ENSYS group,
Chennai

Abstract

The management of biomedical waste is integral to healthcare operations, addressing waste generated during diagnosis, immunization, research, treatment, and various healthcare activities. This comprehensive review aims to outline the landscape of biomedical waste management practices prevalent in healthcare facilities, encompassing various aspects from waste generation to disposal and the latest technological interventions. The article delineates the sources of biomedical waste, primarily stemming from healthcare establishments, veterinary hospitals, research organizations, medical camps, and pharmaceutical entities. While biomedical waste accounts for 15% of a hospital's total waste, its hazardous nature demands stringent management practices. A critical emphasis is placed on the imperative of proper waste segregation. While 85% of hospital waste is non-infectious, the remaining 15%, consisting of infectious and hazardous waste, when combined, escalates the risk, necessitating segregation at the source for distinct treatment and disposal. The Bio-Medical Waste (Management and Handling) Rules formulated in 1998 by the Ministry of Environment and Forests (MoEF), subsequently amended in 2000 and 2016, establish guidelines for healthcare establishments and operators, mandating responsibility for environmental protection and monitored by pollution control boards. Further, the article details the responsibilities associated with biomedical waste management, the categorization of waste, and the final storage points ensuring proper sealing, segregation, and disposal. Innovative technological interventions such as barcoding, GPS tracking, and online monitoring systems are highlighted, showcasing how healthcare establishments like Ken Biolinks have leveraged technology to improve waste inventory recording, transportation tracking, and treatment processes. Treatment methods, including incineration, atomized autoclaves, and effluent treatment processes, are discussed in-depth, shedding light on their respective capacities and functionalities. Additionally, newer technologies like sludge filter presses and online emission monitoring systems are introduced, demonstrating their roles in waste volume reduction and real-time oversight. This article serves as a comprehensive guide, illustrating the multifaceted landscape of biomedical waste management, encompassing regulations, responsible practices, technological advancements, treatment methodologies, and emerging innovations. It emphasizes the critical need for robust waste management practices in healthcare facilities to protect public health and preserve the environment.

Introduction

Biomedical waste means waste, that is generated during diagnosis, immunisation, research or treatment of human beings or animals or research activities pertaining thereto or in the production or testing of biological or health camps. In short, it is nothing but DIRT(S):

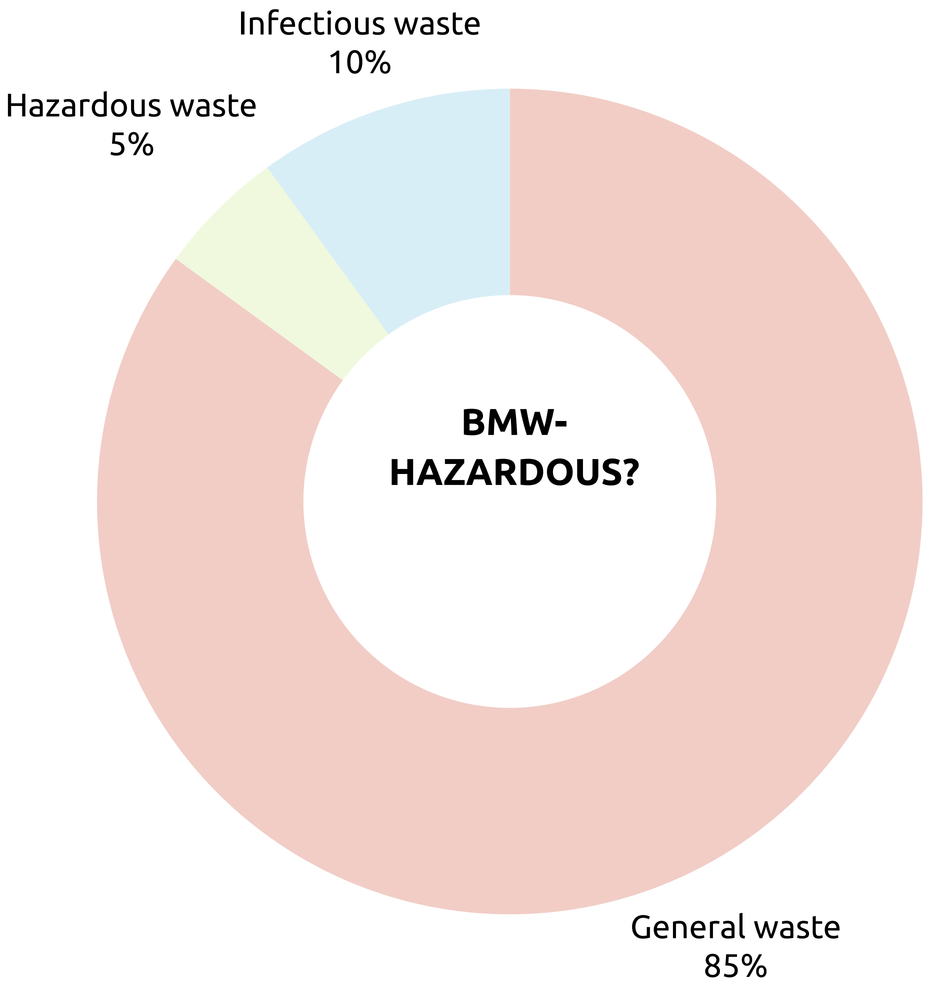


Sources of BMW generation

1. Health care establishments
2. Veterinary hospitals
3. Research organizations
4. Medical camps
5. Pharmaceutical companies/distributors

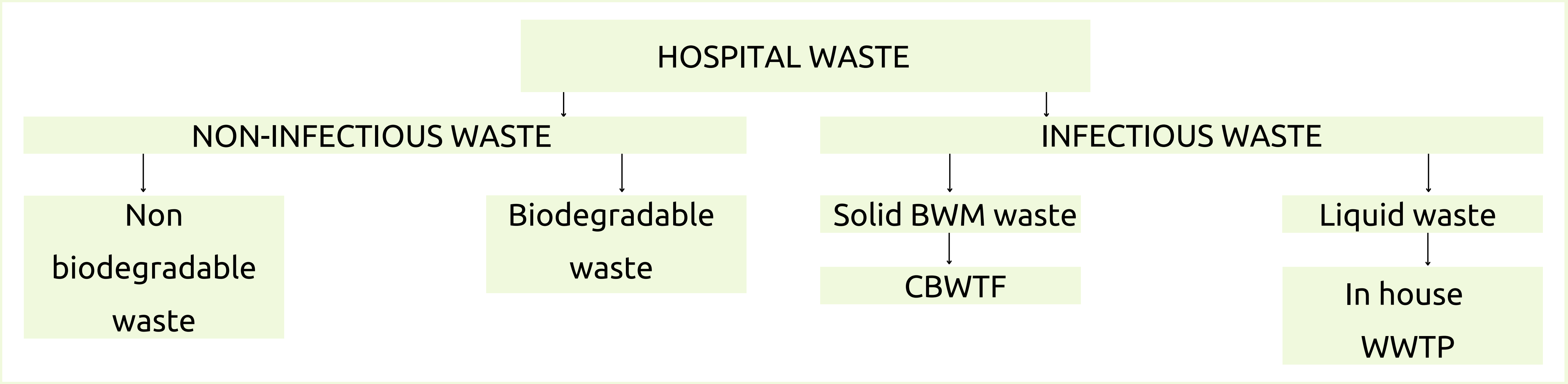
Is BMW-Hazardous?

Biomedical waste (BMW) is hazardous due to its potential risk to public health and the environment. While only constituting about 15% of a hospital's total waste, this fraction contains infectious and hazardous materials, including biomedical sharps, contaminated dressings, pathological wastes, and chemical substances like expired drugs or disinfectants.



When not managed properly, this type of waste can pose severe risks. If infectious or hazardous biomedical waste mixes with non-infectious waste, it can render the entire waste stream hazardous. Therefore, segregation of biomedical waste at its source is crucial to ensure safe handling, treatment, and disposal, preventing any potential harm to individuals, healthcare workers, and the environment.

Types of waste generated in a health care establishment



Why BMW waste segregation is more important?

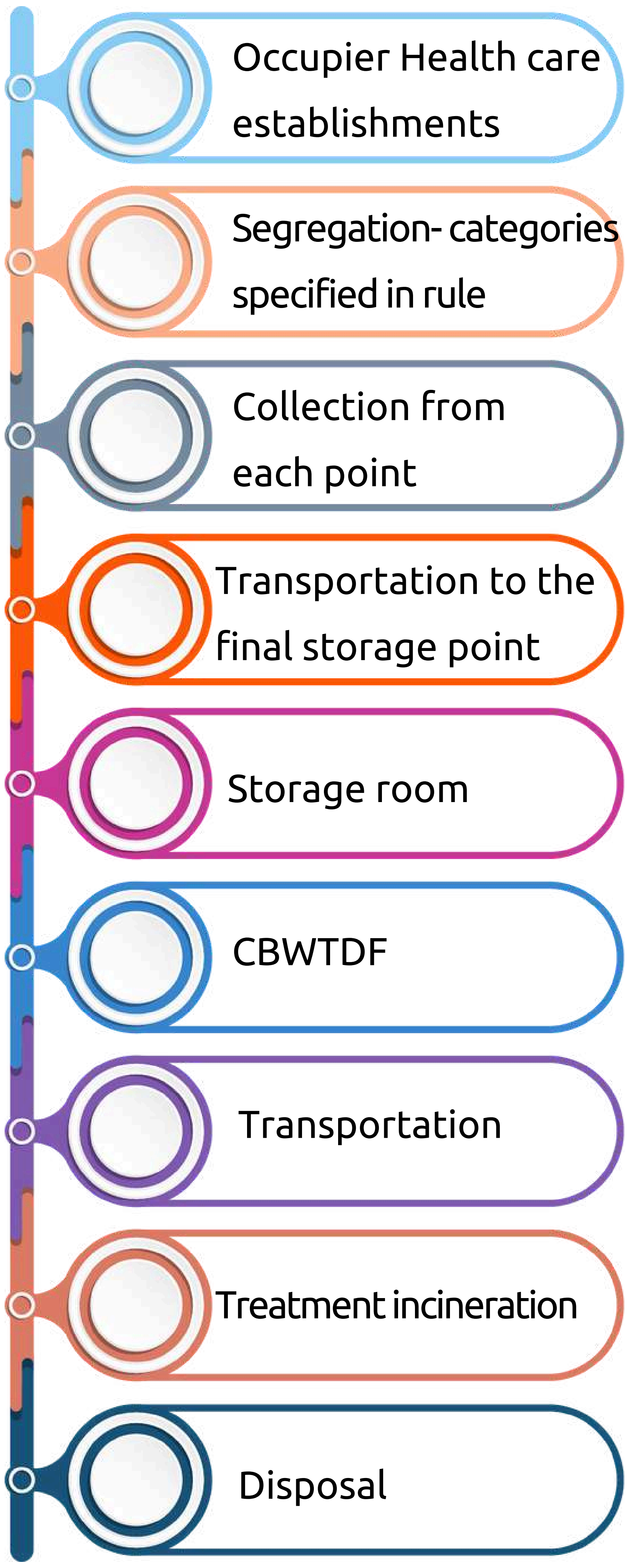
1. 85% of hospital waste is non-infectious (Kitchen waste, paper)
2. 10% of Hospital waste is highlighted as infectious (dressing, anatomical wastes, blood bags)
3. 5% is non-infectious but hazardous (chemical drugs and mercury) When this 15% of the hospital infectious material is mixed with 85%, then all the 100$ waste becomes hazardous and infectious, hence segregation should be done at the source and treated separately before it is disposed of.

Biomedical waste management rules, 2016

Formulated in 1998 by MoEF

- Amended in 2000
- Modified in 2016
- Makes the occupier (Healthcare establishment and operator (common BMW treatment & Disposal facility)) responsible for protecting the environment from hazards, monitored by the state and central pollution control board.

Responsibilities



Biomedical waste categories

CATEGORY: 1 Yellow	CATEGORY: 2 Red
CATEGORY: 3 Blue	CATEGORY: 4 white

Final storage Point

1. The biomedical waste should be stored in a final storage room. It has to be exclusively used for this purpose. It has to be exclusively used for this purpose. It should be cleaned and disinfected regularly.
2. The bags should be sealed properly using tags.
3. The seated yellow and red bags should be placed in the respective containers at the final storage point.
4. The sharp-metals, glassware and metallic implants to be kept in respective containers.

Safety measures (as per BMW rules) at ken biolinks;

1. Recording of waste inventory
2. Bar coding of bags
3. GPS tracking of vehicles carrying such waste
4. Continuous online monitoring of emission system at CBWTF

Key bar stickers

KEY BIO LINKS

VELLORE

Helpline: +91 9947859227

2578581484-5759

SUCCO-HOS_RTP

1 Biomedical waste facility, name

2 Address

3 Phone No

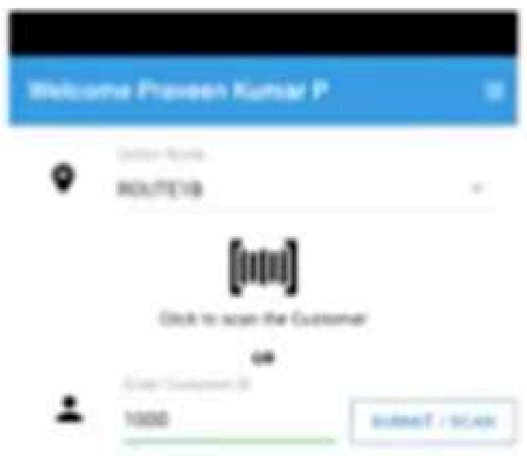
4 Barcode

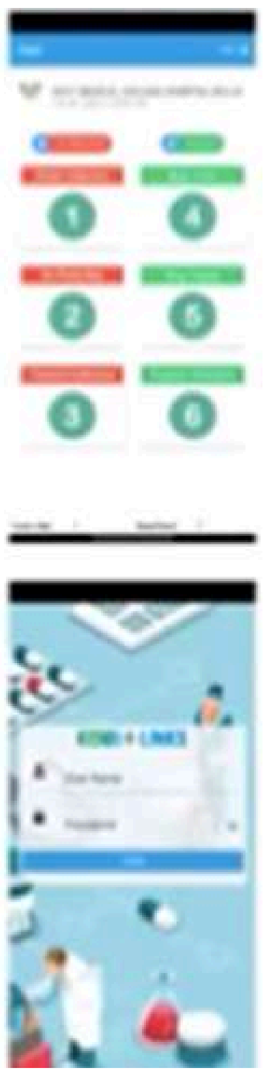
5 Barcode reference no

6 Hospital Name

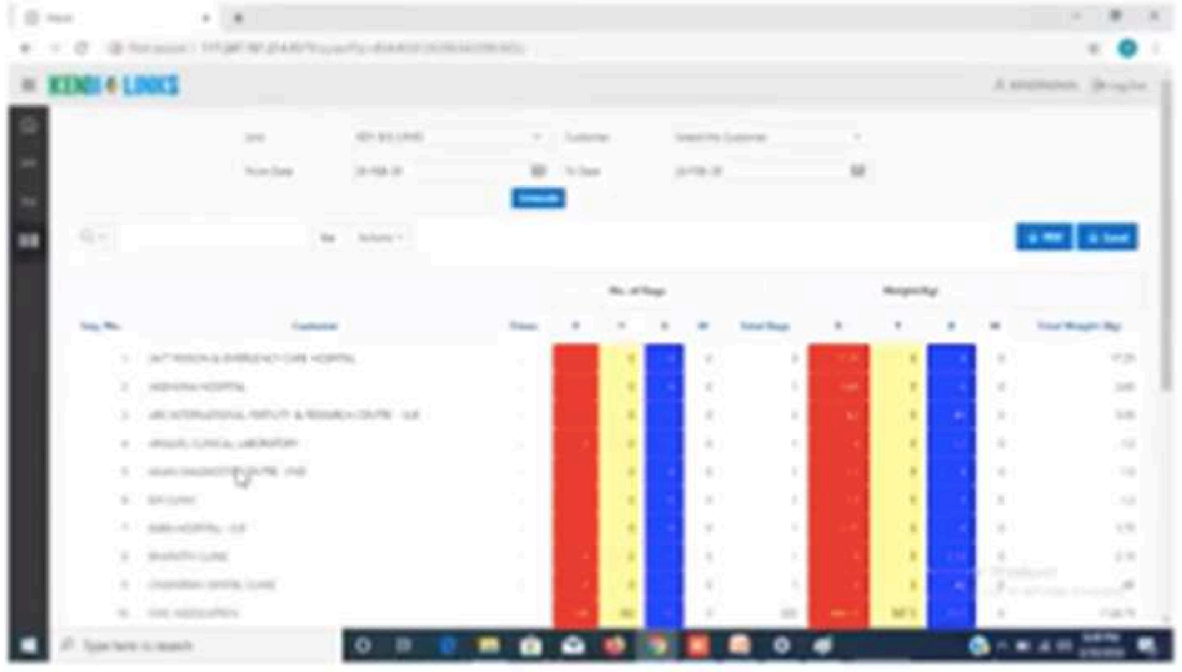
Key bar stickers on linen

Ken biolinks have bar code scanning mobile app for better tracking of the BMW





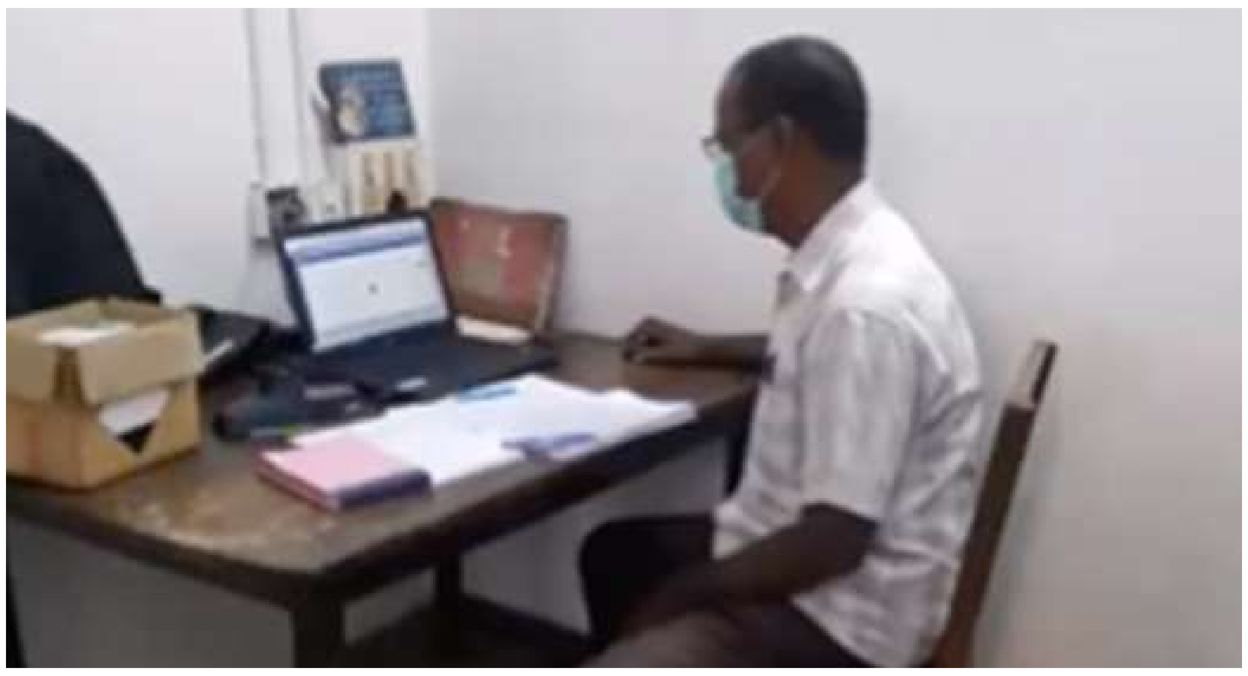
Bar code web portal giving all the details of each hospital to track all the records.



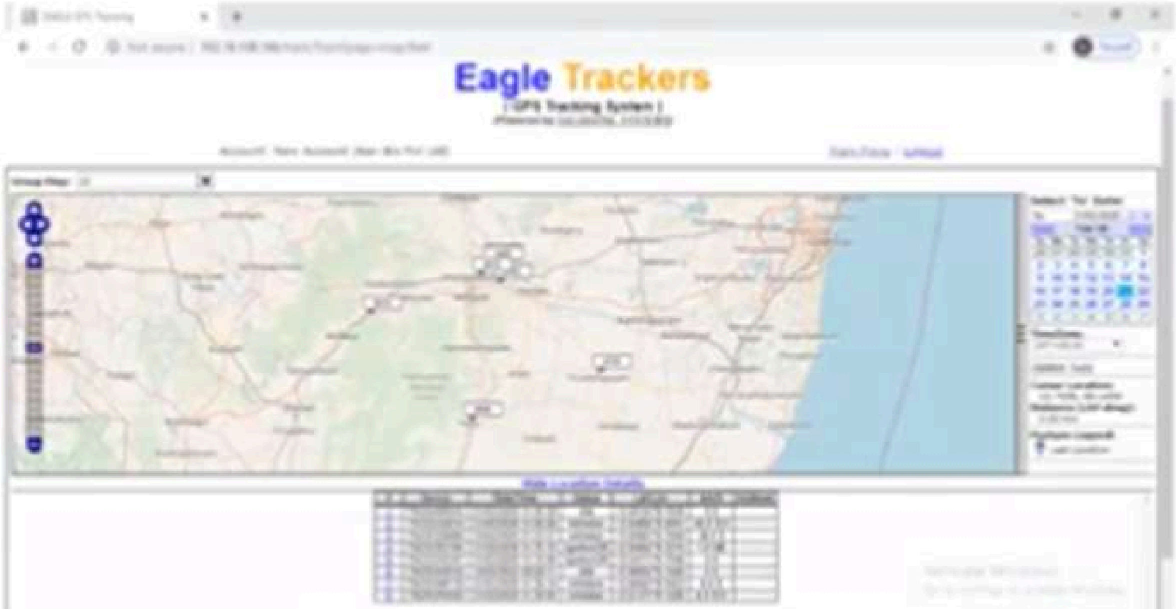
BMW collection

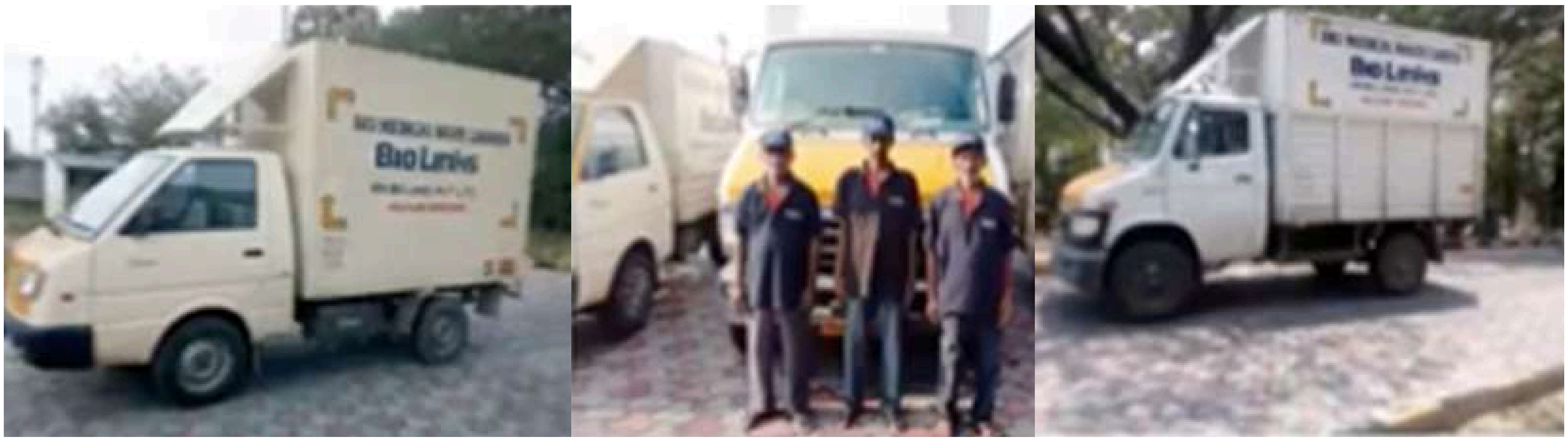
1. Biomedical waste collection and scanned @ HCEs

2. Collecting BMW weight details entering into system



3. Transportation are equipped with GPS: As per biomedical waste management rules 2016 we enabled GPS in all out vehicles. And these service vehicles, which help to track the vehicle in real time.

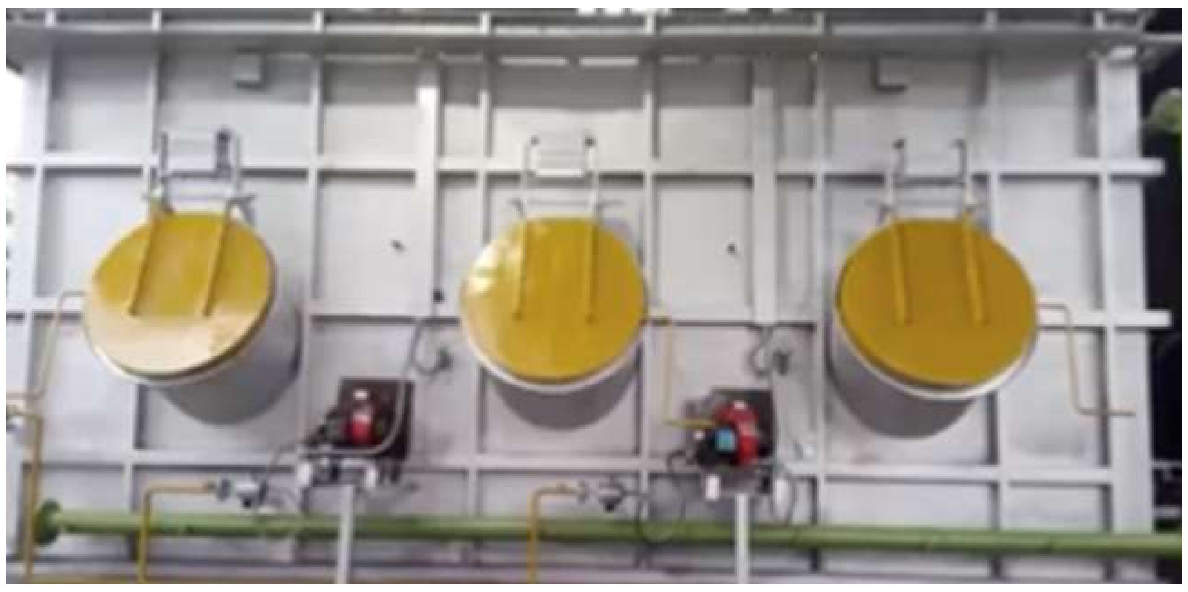




Treatment process at facility

- INCINERATION
- AUTOCLAVING
- EFFLUENT TREATMENT

Incinerator



Capacity: 250-300kgs/hour

Make : ENSYS INDIA, Chennai

Machinery and capacity

	Name of the machine	Manufacturer	Quantity	Capacity
1	Incinerator	Ensys india chennai	1 No	250-300kg\hr
2	Autoclave		1 No	225kg/batch time-90 min
3	Shredder		1 W+1 S	75 kg/hr
4	Effluent treatment plant		1 No	20kld

APC system

Atomized Autoclave

The non-incinerable bio-medical waste collected in red bags and punctures filled containers, will be subjected to steam sterilization using vacuum autoclave.

In this process, the biomedical waste will be completely disinfected and decontaminated. The vacuum autoclave will reach a temperature level up to 121C and a pressure level of 20 PSI.

The operating cycle of each batch will be 45minutes

The autoclave will also have automatic programmable logic controller) data recording instruments so that the temperatures and other relevant information will be available on line and recorded for future reference.

Effluent treatment process

Effluent treatment involves a series of processes designed to purify and remove contaminants from wastewater before its discharge into the environment. The treatment process typically includes several stages:

1. Screening: The first step involves the removal of large objects, debris, and solids from the wastewater using screens or filters. This helps prevent damage to downstream equipment and facilitates subsequent treatment processes.

2. Primary Treatment: In this stage, physical processes such as sedimentation or settling tanks are used to allow suspended solids to settle at the bottom of the tank, forming sludge. This process helps remove a significant portion of solids and some organic matter.

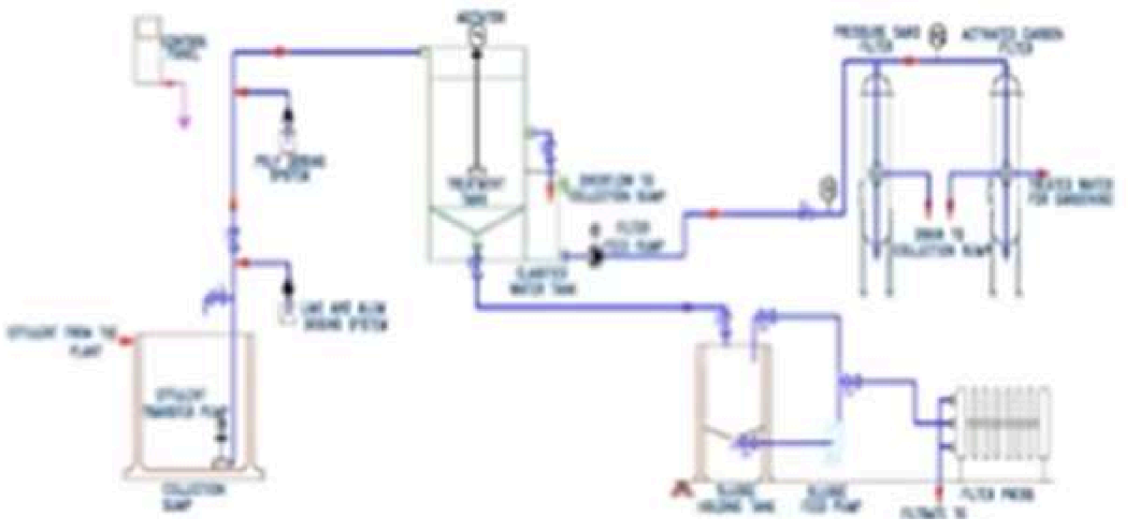
3. Secondary Treatment: This step involves biological processes where microorganisms break down organic matter that escaped the primary treatment. Common secondary treatment methods include activated sludge processes, biological filters, or constructed wetlands. These processes aim to further reduce the organic content and pollutants in the effluent.

4. Tertiary Treatment: Tertiary treatment focuses on the removal of remaining impurities, including nutrients (such as nitrogen and phosphorus) and trace contaminants. Advanced filtration techniques like sand filtration, membrane filtration, or chemical treatments (like chlorination or ozonation) are employed in this stage to achieve high-quality effluent.

5. Disinfection: Before discharge, the treated wastewater undergoes disinfection to kill pathogens and microbes. Common disinfection methods include chlorination, UV irradiation, or zonation.

6.Sludge Treatment: Any sludge generated during the treatment process needs proper handling. Sludge can undergo further treatment steps like digestion, dewatering using filter presses or centrifuges, and sometimes incineration or landfilling.

The overall effluent treatment process aims to reduce the organic load, remove pollutants, and ensure that the discharged water meets regulatory standards, minimizing its environmental impact on receiving bodies of water or land areas.



Treated water

Sludge

Disposal at facility

Shredder for compaction/physical deformation of plastics before end disposal.

Incineration ash filled in HDPE drums and stored at closed shed.

New technologies

Sludge Filter Press- a Sludge after filter press

A sludge filter press is a specialized apparatus used in wastewater treatment to dewater sludge, reducing its volume and facilitating its disposal. This equipment operates by applying pressure to slurry or sludge material, forcing the separation of solids from liquids.

Key components and functions of a sludge filter press include:

- Filter Plates: These plates, typically made of reinforced polypropylene or similar materials, are arranged in a stack within the press. The sludge is pumped into these chambers.

- Pumping System: The sludge is introduced into the filter press using a pumping system that delivers the material under pressure.
- Filtration Process: Once inside the press, the sludge material is subjected to high pressure, which forces the liquid (filtrate) to pass through the filter cloth while retaining the solid components.
- Dewatering: As the pressure is applied, the sludge undergoes dewatering, reducing its moisture content and volume.
- Discharge of Solid Cake: The separated solids form a filter cake, which is discharged from the press, usually in batches, ready for disposal.
- The sludge filter press plays a crucial role in wastewater treatment plants by efficiently managing and minimizing the volume of sludge produced during the treatment process, allowing for easier handling and disposal of the solid waste.

Online emission and monitoring system

An online emission and monitoring system for biomedical waste management (BMW) would involve a digital platform or software designed to oversee and track various aspects of biomedical waste disposal. This system could include real-time monitoring of waste generation, segregation, collection, treatment processes, and disposal methods within healthcare facilities.

Key features might encompass:

1.Real-time Tracking: Monitoring the quantity and type of biomedical waste generated across different departments or units within a healthcare facility.
2.Segregation and Categorization: Ensuring proper segregation and categorization of biomedical waste according to color-coded categories and regulatory guidelines.
3.Treatment Monitoring: Overseeing the treatment processes, whether through incineration, autoclaving, chemical disinfection, or other approved methods, to verify compliance and effectiveness.
4.Transportation Oversight: Tracking the movement of waste from healthcare facilities to treatment and disposal sites, ensuring adherence to safety protocols during transit.
5.Compliance and Reporting: Facilitating compliance with regulatory standards by generating reports, maintaining records, and alerting authorities about any deviations or irregularities.
6. Environment Impact Assessment: Providing data on the environmental impact of waste management practices, including emissions, to facilitate better environmental management.

Such a system, when integrated into biomedical waste management practices, can streamline operations, enhance transparency, and ensure adherence to guidelines, ultimately promoting more effective and environmentally responsible waste disposal.

“Let the waste of the sick not contaminate the lives of healthy”

Liquid Waste Management

Mr. Vinod Kumar KB
Consultant FMS, Rajagiri Hospital, Aluva, Consultant & Head,VBG consulting engineers, Aluva

Abstract

The liquid waste management in healthcare facilities highlights the various sources, sewage treatment plant (STP) processes, and essential considerations. The liquid waste originates from diverse healthcare activities, from patient care to diagnostic procedures, surgeries, and general hospital operations.

Effective management of this waste is crucial for environmental safety and regulatory compliance. The article delves into the intricate workings of STPs, outlining their multi-stage treatment processes. From preliminary and primary treatments involving debris removal and settling tanks to advanced secondary and tertiary treatments, such as biological processes and disinfection, each step aims to produce treated water meeting regulatory standards. Furthermore, the article explores the sewage and sullage composition, the significance of biochemical oxygen demand (BOD), and chemical oxygen demand (COD) in sewage quality assessment. Lastly, it is important to emphasise the criticality of sludge disposal, discussing digestion and subsequent drying bed treatment for sludge reuse as organic fertilizer, adhering to environmental guidelines.

Introduction

Liquid waste generated in hospitals can come from various sources within the healthcare facility.
Some common sources include:

- Patient Care Activities: Fluids used for patient care, such as bodily fluids (blood, urine, and excretions), irrigation fluids, dialysis fluids, and wound irrigation solutions.
- Laboratory and Diagnostic Procedures: Chemical reagents, solutions, and fluids used for diagnostic testing, such as blood tests, cultures, and analyses.
- Operating Theatres and Surgical Procedures: Waste generated during surgeries, including used irrigation fluids, cleaning solutions, and other surgical fluids.
- Radiology and Imaging Departments: Fixer and developer solutions, contrast agents, and other chemicals used in imaging processes.
- Pharmaceutical and Drug Administration: Expired, unused, or contaminated medications and solutions, including intravenous fluids and drug preparation residues.
- Housekeeping and Cleaning Activities: Wastewater from cleaning and disinfection processes, floor washing, and equipment sterilization.
- Kitchen and Food Services: Wastewater from kitchen activities, including food preparation, dishwashing, and cleaning.

Proper management of liquid waste from these sources is crucial to prevent environmental contamination, ensure compliance with regulations, and protect public health. Treatment and disposal of liquid medical waste often involve specialized processes to minimize environmental impact and potential health risks.

Sewage treatment plant (STP)

A sewage treatment plant (STP) is a facility designed to treat wastewater or sewage from residential, commercial, and industrial sources before it released back into the environment.

The primary goal of an STP is to remove contaminants, pathogens, and pollutants from sewage to produce treated water that is safe for disposal or reuse.

The process in an STP involves several stages:

1. Preliminary Treatment: Large debris, solid materials, and grit are removed through physical processes such as screening to prevent damage to downstream equipment.
2. Primary Treatment: The sewage enters settling tanks were suspended solids settle at the bottom as sludge, while grease and oil float to the surface, forming scum. This step removes a significant portion of solids and some organic matter.
3. Secondary Treatment: Biological processes are used to further treat the wastewater. Microorganisms break down organic matter in the sewage through aeration tanks, activated sludge processes, or biofilters. This stage significantly reduces the organic content and pollutants.
4. Tertiary Treatment: Advanced treatment methods are employed to further improve the quality of the treated effluent. Processes like filtration (sand or membrane),disinfection (chlorination, UV radiation), or nutrient removal (phosphorus, nitrogen) are used to ensure the water meets required standards.
5. Sludge Treatment: Any sludge generated during the treatment process undergoes further treatment. This includes thickening, digestion to reduce its volume and pathogen content, dewatering to remove excess water, and sometimes incineration or use as fertilizer.

The treated water, also known as effluent, is then discharged into water bodies or reused for non-potable purposes like irrigation or industrial processes. Sewage treatment plants play a crucial role in protecting public health, preserving the environment, and conserving water resources by ensuring the safe disposal or reuse of wastewater.

Scheme as per BMW rules, 2016

Sewage and Sulage

Sewage is waste water from a community, containing solid and liquid excreta, derived from houses, street and yard washing, factories and industries.

The term sullage is applied to waste water which does not contain excreta, e.g. waste water from kitchen and bathrooms.

Composition of sewage

Water: 99%
Organic and inorganic solid: 0.1%
One gram faeces may contain about 1000 million E.Coli, 10-100 million faecal streptococci, and 1-10 million spores of Cl. Perfringens.

Decomposition of organic matters

Aerobic process: In the presence of oxygen organic matter is broken down into CO2, water, ammonia, nitrites, nitrates and sulfates by action of bacterial action including fungi and protozoa.

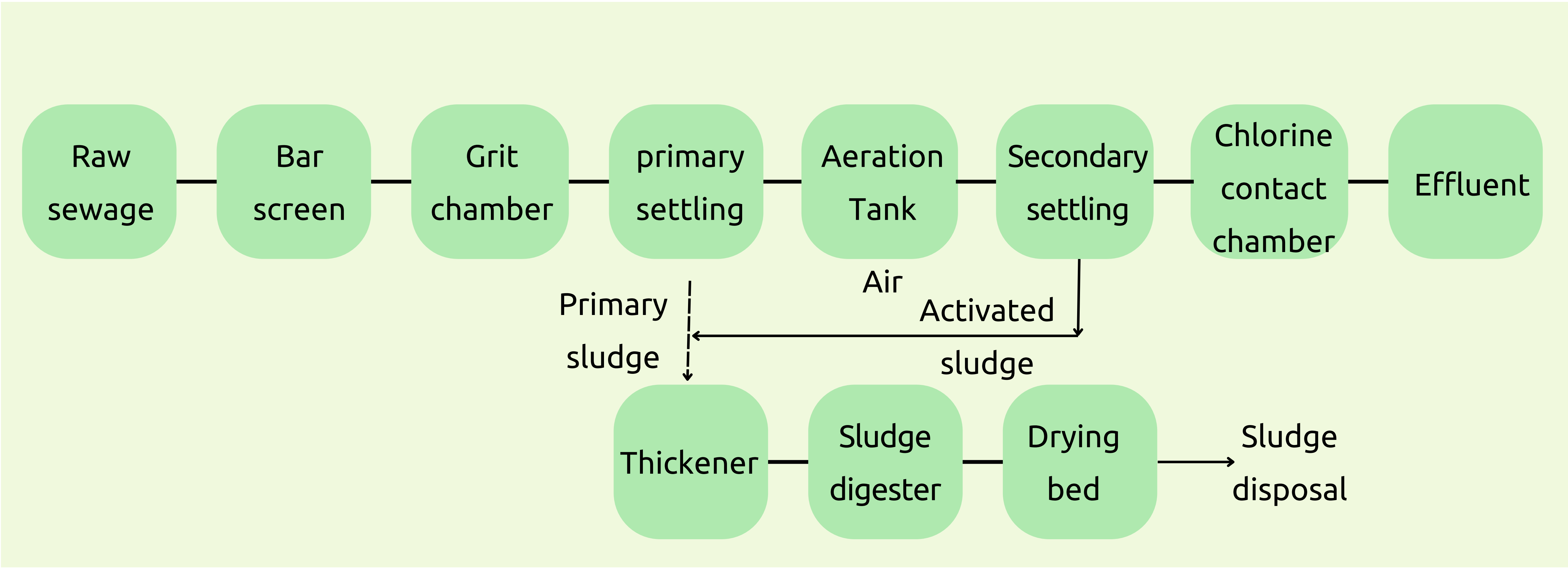
Anaerobic process: Anaerobic bacteria decompose organic waste into methane, ammonia, co2 and H2.

AIM of a sewage plant

To stabilize the organic matter so that it can be disposed off safely and to convert the sewage water into an effluent of an acceptable standard of purity which can be disposed of in to land, rivers
or sea.

A standard test which is an indicator of the organic content of the sewage is biochemicaloxygen demand (BOD).BOD is defined as the amount of oxygen absorbed by a sample of sewage during specified period, generally five days, at a specific temperature, generally by living organism.

BOD value ranges from 1mg/liter for natural water to 300mg/liter for untreated sewage. Chemical oxygen demand (COD) is a test that measures the amount of oxygen required to chemically oxidize the organised material and inorganic nutrients, such as ammonia or nitrate, present in water. The permissible limit of COD is 250 to 500ppm.



Schematic shows the waste water treatment process.

Screening

Sewage first passed through metal scree to remove large floating objectives such as pieces of woods, rags, plastics paces, masses of garbage and dead animals.

GRIT Chamber

After screen sewage is then passed through a long narrow chamber called as grit chamber or
detritus chamber.

The chamber is about 10-20 meter and velocity of sewage flow is about 1 foot per second taking a detention period of 0.5-1minute.

The grit chamber allows to settle down heavier solids such as sand and gravel while permitting the organic matter passing through. The grit collected at the bottom of chamber is removed periodically or continuously.

Primary sedimentation

After passing through sewage is then admitted to a huge rectangular tank called as primary sedimentation tank. Sewage is made to flow very slowly across the tank at a velocity of 1-2 feet/minute and retained 6-8hours in tank. Nearly 50-70% organic solids settled down due to gravity. The sludge is removed mechanically operated devices and subjected to sludge dryer. Due to biological action certain treatment takes place. Scum at the uppermost layer should be removed periodically.

Secondary sedimentation

The effluent from the primary sedimentation tank still contains a proportion of organic matters in solution and numerous living organism. It has high oxygen demand and subjected to further treatment 'aerobic oxidation' by one of the following methods:

- Trickling bed filter method
- Activated sludge process

Activated sludge process

Subjected to aeration chamber for aeration for 6-8hours. The aeration is accomplished by either mechanically agitation or by forcing compressed air continuously from the bottom of aeration tank. The organic matter of the sewage gets oxidized into CO2, nitrates and water with the help of aerobic bacteria.

Chemical disinfection

To inactivate pathogens in wastewater.

Several choices are as follows:

1. Free chlorine and combined chlorine
2. UV
3. Ozone
4. Chlorine dioxide

Ultra-filtration

Ultrafiltration is a water treatment process that uses a hollow fiber or sheet membrane to mechanically filter water containing very small particulate. An ultrafiltration drinking water system uses this super fine membrane technology to filter particulate down to 0.025.

A UF system can filter most solid particulates in fluids, but cannot filter out dissolved particulate like RO plant. It can filter out inorganic solids, viruses, and bacterial because of their sizes.

Sludge disposal

3-4 weeks complete digestion takes place and it is carried out in sludge drying bed. Digested sludge is used as organic fertilizer for agricultural purpose.

Conclusion

In essence, the comprehensive overview of liquid waste management within healthcare facilities underscores its diverse sources and the pivotal role of sewage treatment plants (STPs) in ensuring effective waste treatment. The article meticulously details the spectrum of waste origins, spanning patient care, diagnostics, surgeries, and hospital operations, emphasizing the necessity for stringent waste management protocols to safeguard the environment and align with regulatory mandates.

The delineation of STP intricacies, encompassing various stages from initial debris removal and primary treatment to advanced biological and disinfection processes, underscores the concerted effort to produce treated water meeting stringent regulatory criteria. Additionally, the exploration of sewage and sullage composition, along with the evaluation of biochemical oxygen demand (BOD) and chemical oxygen demand (COD), highlights key parameters vital for sewage quality assessment.

Crucially, the discourse culminates by underlining the significance of proper sludge disposal methods. The discussion on sludge digestion and subsequent drying bed treatments, aimed at repurposing sludge as organic fertilizer while adhering to environmental directives, amplifies the holistic approach toward sustainable waste management practices in healthcare settings.

The collective insights elucidated within this article underscore the complexity of liquid waste management in healthcare, advocating for a meticulous approach that integrates various treatment processes and emphasizes responsible waste disposal methods.

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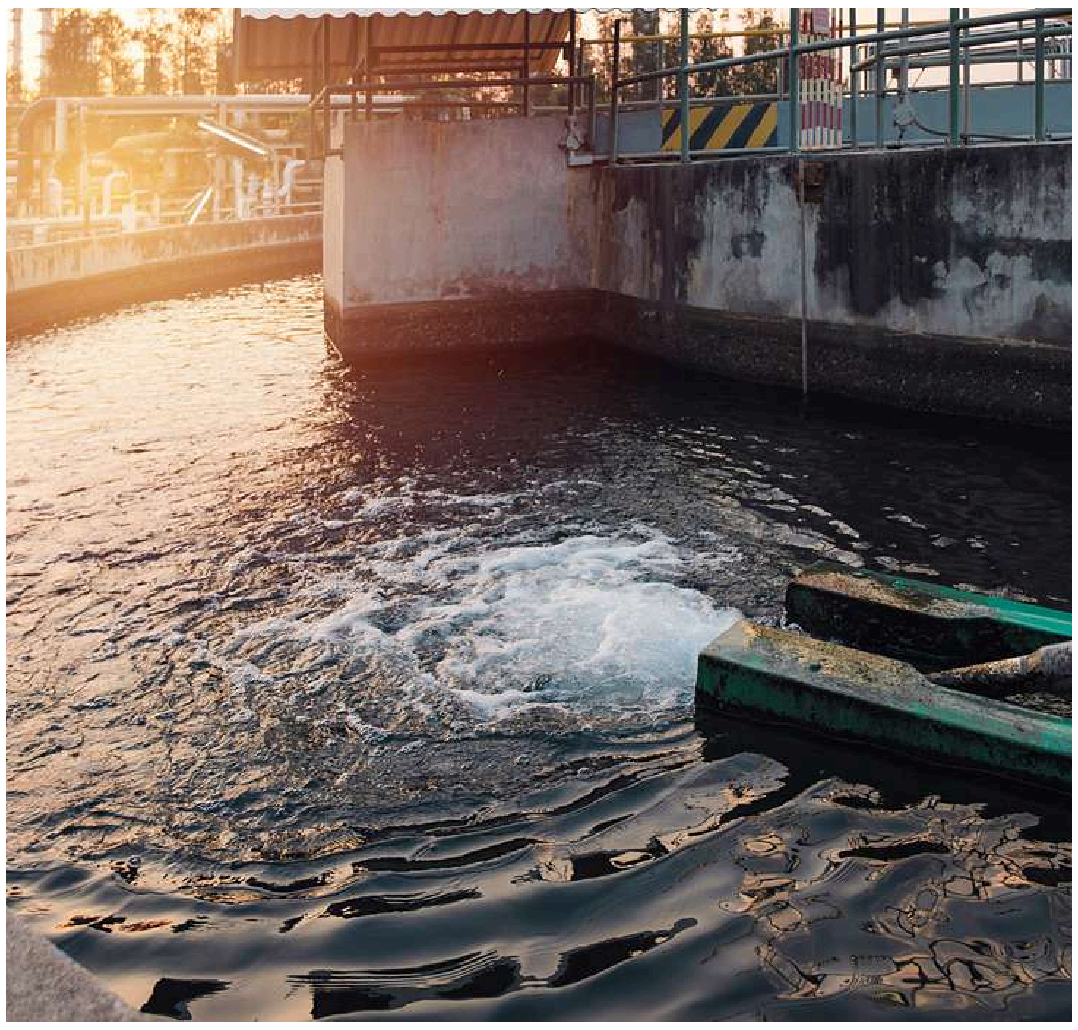

Approaches to E-Waste, Battery Waste Disposal in Healthcare Facilities

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Abstract

Healthcare facilities are prolific generators of electronic waste (e-waste) and battery waste, posing environmental and health risks due to hazardous components like lead, mercury, and cadmium. Disposal mismanagement of these wastes can result in severe consequences, including environmental contamination and adverse health effects. This article delineates strategies for proper e-waste and battery waste management in healthcare settings, emphasizing the need for responsible disposal practices to mitigate environmental impact and safeguard public health.

Introduction

Healthcare facilities are major generators of electronic waste (e-waste) and battery waste, due to the extensive use of medical equipment, diagnostic devices, and power tools. Improper disposal of these wastes can pose significant environmental and health risks, as they contain hazardous substances such as lead, mercury, and cadmium. Therefore, it is crucial for healthcare facilities to implement proper strategies for managing and disposing of e-waste and battery waste in an environmentally responsible and safe manner.

E-Waste Management

E-waste encompasses a wide range of electronic products, including computers, monitors, printers, scanners, medical equipment, and batteries. Improper disposal of e-waste can lead to the release of toxic chemicals into the environment, contaminating soil, water, and air. These pollutants can harm human health, causing respiratory problems, neurological disorders, and even cancer.

To effectively manage e-waste in healthcare facilities, the following strategies can be implemented:

- Establish a dedicated e-waste collection program: Designate specific containers or bins for the collection of e-waste, ensuring they are clearly labelled and located in accessible areas.
- Reduce e-waste generation: Encourage the use of eco-friendly alternatives, extend the lifespan of equipment through proper maintenance, and consider leasing or renting equipment instead of purchasing.
- Segregate waste streams: Separate e-waste from other waste streams, such as regular trash or hazardous waste, to minimize contamination risks.
- Conduct audits and inventory management: Regularly conduct audits to track e-waste generation and identify areas for improvement in waste reduction and management practices.
- Source separation and recycling: Collaborate with certified e-waste recyclers who follow strict environmental and safety guidelines. Require recyclers to provide documentation of proper disposal practices.

- Community involvement: Engage with local recycling organizations and participate in community e-waste collection events to expand the reach of waste management efforts.

Battery Waste Management: Batteries contain valuable metals such as lithium, cobalt, and nickel, but they also pose environmental and health risks due to the presence of hazardous materials like lead, cadmium, and mercury. Improper disposal of batteries can lead to fires, explosions, and the leaching of toxic chemicals into the environment.

Strategies for Battery Waste Management in Healthcare Facilities: To manage battery waste effectively, consider the following strategies:

- Set aside particular containers for collecting batteries: Provide easily accessible, clearly labelled containers for gathering several kinds of batteries, including rechargeable, lithium-ion, and alkaline batteries.
- Assist initiatives that recycle batteries: Work together with authorized recyclers of batteries that are experts in handling and processing different kinds of batteries securely.
- Encourage the use of reusable batteries: Promote the longer usage of rechargeable batteries before their disposal.
- Provide battery swapping initiatives: To reduce the amount of used batteries that accumulate, implement initiatives that encourage the exchange of old batteries for new rechargeable ones.
- Implement battery safety protocols: Provide clear guidelines for the safe handling, storage, and disposal of batteries, especially those containing hazardous substances.

Regulation Compliance: When it comes to the handling of battery waste and e-waste, healthcare institutions need to follow all applicable local, state, and national rules. By guaranteeing that these hazardous wastes are handled, recycled, and disposed of properly, these rules seek to safeguard both the environment and human health. For effective disposal of this waste refer to the policy published by the Government of India under the Ministry of Environment, Forest, and Climate Change. The forms that need to be submitted to the Pollution Control Board (PCB) concerning e-waste and battery waste are as follows:

For e-waste:

- Form 1 (a): Application for authorization to collect, transport, process, or recycle e-waste
- Form 4: Application for authorization to dismantle e-waste
- Form 6: Application for authorization to incinerate e-waste
- Form 7: Application for authorization to import e-waste
- Form 8: Application for authorization to handle e-waste as hazardous waste

For battery waste:

- Schedule I: Report on the generation, collection, and disposal of battery waste

- Schedule II: Report on the storage and transportation of battery waste
- Schedule III: Report on the management of hazardous substances in battery waste
- Schedule IV: Report on the disposal of hazardous substances in battery waste
- Schedule V: Report on the compliance with the Battery Waste Management Rules, 2022

In addition to these forms, healthcare facilities may also need to submit other reports or documents to the PCB, such as:

- An annual report on e-waste and battery waste generation
- A list of designated collection points for e-waste and battery waste
- Proof of registration with a recycler or disposal facility
- Details of any incidents or accidents involving e-waste or battery waste

Healthcare facilities should consult with the PCB in their jurisdiction to determine the specific forms and reports that are required.

Conclusion

The effective management of electronic and battery waste within healthcare facilities is paramount to mitigate environmental degradation and health hazards. Strategies outlined for e-waste encompass dedicated collection programs, waste reduction measures, segregation, audits, recycling collaborations, and community engagement.

Similarly, battery waste management strategies advocate for proper collection, education on handling and recycling, promotion of reusable batteries, and safety protocols. Compliance with governmental regulations, specifically adhering to policy guidelines and submitting requisite forms to the Pollution Control Board, ensures lawful and responsible disposal. Healthcare institutions must prioritize these practices, comprehensively managing e-waste and battery waste to minimize their environmental footprint and protect human health, thereby ensuring the ethical and sustainable disposal of these hazardous wastes.

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Preserving health, Preserving Earth: Managing waste for a sustainable tomorrow.

From Waste to Wellness: Integrating Reduce, Reuse, Recycle in Healthcare

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Abstract

‘Reduce, Re-use and Re-cycle’ (3R) in general is a concept for sustainable living and resource management. Specific to the healthcare context, it will be an approach aimed at minimizing the environmental impact of healthcare activities by managing resources and wastes more efficiently. Hospitals can significantly reduce their waste by combining waste prevention with a comprehensive recycling effort. These principles align with broader environmental conservation efforts and contribute to the overall goal of creating a more environmentally friendly and responsible healthcare industry.

So, does the concept of 3R mean we could reuse the Biomedical waste generated? The answer is no. Much of the waste produced by healthcare facilities isn’t outright hazardous. As long as the waste isn’t mixed with dangerous or contaminated waste, much of it can be reused or recycled. However, the challenge for healthcare set-ups will be in implementing a rigorous segregation program. Sorting health care waste after it’s been mixed is extremely hazardous, hence the utmost importance of the 3R concept will be appropriate segregation at source.

Some of the measures that hospitals can take related to 3R include the following: **Reduce Concepts:**

Minimizing Consumption: Optimizing inventory, and ensuring the reduction of wastes at the source are some of the concepts Hospitals could look at. Digitalization of records and reducing the usage of packing items, using hand dryers instead of paper towels could be some ways of looking at waste reduction.

Energy Efficiency: A number of methods of energy efficiency in a hospital could be implemented right from the planning stage of the hospital building. Energy efficiency could include the methods of usage of natural lighting, ventilation, motion sensor lighting, controlled water dispensing from taps, re-cycling of STP water and RO water for alternate consumptions etc.

Waste Audit: Conducting regular waste audits can help hospitals identify the types and amounts of waste they generate. This information is valuable for developing targeted strategies to reduce specific types of waste and improve overall waste management practices at the hospital.

Re-use: If an item can no longer serve its original purpose, finding new ways to use it or passing it on to others in need (if it is no longer use in your institution), extends its lifespan and reduces the need for new products. Whenever possible, healthcare facilities can opt for medical equipment that is designed to be reusable. This includes items such as certain medical devices that can be sterilized and used multiple times, reducing the need for disposable alternatives. Hospitals can explore alternatives to single use items by promoting the use of durable, reusable products (were feasible).

This can include re-usable linens, plates and glasses etc.

Re-cycle: When reduction and reuse are not possible, recycling becomes a valuable option. However, recycling processes themselves may require energy and resources, making it a less preferable option compared to the first two. Products that can be recycled includes cardboard, office paper, aluminium cans, glass bottles, newspapers, plastics, and steel cans used by food service. Not only do these practices lower the amount of waste, but they also save the hospital money in the process.

Benefits of 3R Concept in Healthcare Set-up

- **Cost Savings:** Implementing 3R can lead to significant cost savings for healthcare facilities. It contributes to the long-term viability of healthcare facilities by promoting efficient resource use and reducing reliance on disposable items.
- **Environmental Impact:** Adopting 3R helps reduce the environmental impact of healthcare activities by diverting materials from landfills and promoting responsible waste management. The 3R concept can also help in the conservation of resources.
- **Goodwill:** Adopting environmentally conscious practices positively influences public perception. Patients and the community at large often appreciate and support such sustainable institutions.
- **Innovation and Efficiency:** Sustainable practices can drive innovation within the healthcare settings, encouraging the development of new technologies, processes and materials that are environmentally friendly.

For the 3R Concept to be implemented in the healthcare set-up effectively, it is important the commitment of the departmental leaders and frontline staff to ensure an appropriate waste segregation policy. One of the main causes of excess medical waste is the improper disposal of non-hazardous items that are either mistaken for biohazardous waste or are incorrectly disposed of due to carelessness. Keeping biohazardous waste containers strictly in areas of the hospital where they are necessary is a good way to reduce the amount of waste generated, as employees and patients will be less likely to wrongly dispose of waste that is meant to be recycled or placed in a non-hazardous waste container. Ensuring all containers are labelled with large symbols and letters to avoid these types of mistakes. Hazardous waste must be disposed of and not recycled, so your best bet in reducing this type of waste is to make sure biohazardous waste is being disposed of properly.

I would like to conclude this write-up with a quote I came across on social media: “Refuse what you do not need, reduce what you do need, reuse what you consume, recycle what you cannot refuse, reduce or reuse, and rot (compost) the rest.”

As healthcare becomes more complex the wastes generated becomes harder to get rid of. With appropriate waste management methods and sensible purchase and inventory management in healthcare, we shall be able to contribute towards a sustainable environment. And the concept of Reduce, Re-use and re-cycle will be a collective action for good by healthcare settings.

Reduce, Reuse & Recycle: Possible ways in a healthcare setup

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The most debatable topic today remains to be Global warming and the protection of our natural resources by reducing the amount of waste produced and its catastrophic impact on the planet.

WHO's response to these challenges centres around 3 main objectives;

- Promote actions that both reduce carbon emissions and improve health
- Build better, more climate-resilient and environmentally sustainable health systems
- Protect health from the wide range of impacts of climate change.

Keeping in mind the objectives laid down by WHO, every healthcare care, whether a 2000-bed teaching hospital or a 10-bed nursing home can contribute to the benefits of Reducing, Reusing and recycling to help sustain the environment for future generations.

According to WHO this can be achieved by:

- Leadership and Raising Awareness
- Evidence and Monitoring
- Capacity Building and Country Support

Becoming a holistically cost-effective healthcare organization and partnering with the national and global mission of creating an eco-friendly atmosphere can be achievable by a focused action plan and setting realistic targets to achieve the set goals in a healthcare organization.

Each healthcare setup first needs to assess the different areas in the hospital, about the type and quantity of items that are required and used, then reconfirm and reposition its requirements, followed by analysing its reusability and lastly recycling methods. A few of the major and vital areas of consumption are Nursing stations, OT, CSSD, LAB, Housekeeping and linen management, Kitchen and so on.

Employee engagement

Employee participation is one of the major contributions to any achievement. The timeline and duration of achievement are directly proportional to the number of employees involved in the mission. Thus rate of consumption, waste generation and recycling effectiveness depends on the motivation, involvement, and encouragement of the employees. Creating opportunities to gain their support will go a long way to reducing your organization's carbon footprint while building a more positive eco-friendly culture.

Some of the ways this can be done are:

- **Leadership support and involvement:** share the objectives and goal, communicate the action plan and share ownership
- **Start a green team:** Establish a committee that can formulate a mission statement and reach out to all areas of the organization to motivate action.

- **Encourage a lot of brainstorming sessions** – these sessions may be converted to achievable target-oriented goals.
    - The committee may lead by example by adopting to limited consumption practices and Zero waste.
- Encourage innovative/unique ideas and executive them example, once a week “no car day/ car pool day” etc
- Acknowledge and applaud. Recognise employee’s actions and contributions.
- Develop policies and guidelines based on the positive outcome of the action plan. For example, enforce a ‘Print policy’.
- Set targets and monitor and report on success.

The below sample table is designed as an example to assist in self-assessing own status in the process of contributing to Reduce, Reuse, Recycle in different areas of their setup:

	Reduce	**Reuse**	**Recycle**
Patient rooms- Housekeeping & Linen management	Analyse usage and opportunities of usage	Limited use of disposables and use of refills	In-house tailor can recycle linen items for reusability in different form
Nursing stations	Analyse use of items at desk, dressing trolleys and medicine cupboards and reset inventory	Seek opportunities to replace single use to reuse as per product instruction and other related guidelines	Seek assistance of green committee
Biomedical waste, chemical and e-wastes	As per state and central BMW guidelines		
Pharmacy and Stores	·Purchase if necessary and under regular consumption ·Reusable bags to bring items from pharmacy or store	Device and adopt best out of waste policy and ideas	Collaborate with groups/organization having similar interests of recycling
Medical Devices	OR Kit Reformulation ; Use products with minimal packaging; Anaesthetic gas reduction	Reprocessing of devices	As per guidelines

Radioactive material	As per guidelines and best practice studies		
Food	Served in reusable dishware and cutlery	Hygienic and clean food can be handed over to agencies for the needy with dignity	Adopt Composting methods
Stationery	Controlled use of paper and other items	Device and adopt best out of waste policy and ideas	Collaborate for best out of waste agencies
IT	Enforce a print policy	Use HMS	E-waste as per policy
Infrastructure	Use energy efficient appliances & gadgets in OT and critical care areas to their full potential		

Here are some ways to reduce in a hospital;

- Strict adherence to BMW management state and centre guidelines and compliance training.
- Post signage for a better understanding of doing the right thing and preventing wastage.
- Replace single-use products with reusable products (if recommended keeping intact the safety of patients, employees and the hospital)
- Before buying a product, check if it can be used again. In addition, review the instructions of the manufacturers along with the state regulations to ensure you're allowed to reuse the product.
- Perform waste audits -periodically review to see if your plan is coming to actionable goals and if your medical waste is being disposed of properly. Let your staff know about the findings and retain them if necessary.

Recommendations

- **Composting:** Wet waste or food waste is one of the major contributors to the total waste produced in a healthcare organization. Out of the 3 Rs recycling, if done by the best method suitable for the set up may be adopted to reduce the amount of greenhouse gases that are sent into the atmosphere and the best way to do this is by composting. Those organisations that have the scope of backyard or vermicomposting may think about doing so as sending to landfill, which leads to decomposing in the absence of oxygen contributing to methane production.
- **Energy management:** The energy management topic may be a key point of concern to be discussed with management to ensure ongoing attention and confirmed timely resolution. This can be achieved by Monitoring and analysing the energy consumption regularly and benchmarking the amount of energy used in your organization. Advocating energy-saving opportunities by bringing process change. Biomedical equipment both critical and non-critical, downtime must be analysed for the payback period and initiative must be taken for the best opportunities to lower consumption and cost.

“Reuse and upcycling of common household goods have been an integral part of Indian culture. Taking a cue from this shared habit, the Ministry of Housing and Urban Affairs (MoHUA) campaign – 'Meri LiFE, Mera Swachh Shehar' is launched to champion the RRRs of waste management- Reduce, Reuse, and Recycle.” -Ministry of Housing and Urban Affairs, Govt. of India

Healthcare organization and setups may further take a cue from the government campaign and collaborate for the mission to protect and preserve environment by bringing about a behavioural and process change in our day to day healthcare activity.

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> Healthcare's triple remedy: Reduce, Reuse & Recycle for a sustainable future.

Infection Control and Environmental impact in Waste Management

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Any waste created during human or animal diagnosis, treatment, or immunization is called biomedical waste (BMW). It contains syringes, needles, scalpels, blood, body parts, toxic chemicals, pharmaceuticals, medical devices, radioactive substances, and other potentially infectious objects. Every day, relatively large amount of potentially infectious and hazardous waste are generated in the health care hospitals and facilities around the world. These substances pose a great threat to the environment and can pollute the air, water and land if not properly disposed. In 2015, a joint WHO/UNICEF assessment found that just over half (58%) of sampled facilities from 24 countries had adequate systems in place for the safe disposal of health-care waste.

Biomedical waste generated can be general, infectious, sharps, radioactive and genotoxic, chemical and pharmaceutical. Between 75% and 90% of the waste produced by health-care providers is comparable to domestic waste and usually called "non-hazardous" or "general health-care waste. The remaining 10%–25% of health-care waste is regarded as "hazardous" out of which 10% are infectious and around 5% are chemical/radioactive. However, if the hazardous waste are not properly segregated at source, the entire general waste can become hazardous .

Infectious waste may contain any of a great variety of pathogenic microorganisms. Pathogens in infectious waste may enter the human body by a number of routes: through a puncture, abrasion, or cut in the skin; through the mucous membranes; by inhalation; by ingestion and can cause both local and systemic infections. Some examples of infections are Salmonella, Shigella, Mycobacterium tuberculosis, Streptococcus pneumonia, acquired immunodeficiency syndrome (AIDS), hepatitis A, B, and C, and helminthic infections. The existence of bacteria resistant to antibiotics and chemical disinfectants in effluent treatment plants may also contribute to the hazards created by poorly managed health-care waste and can spread antimicrobial resistance to the community.

Sharps on the other hand are equally dangerous. Worldwide, an estimated 16 billion injections are administered every year. Not all needles and syringes are disposed of safely, creating a risk of injury and infection and opportunities for reuse. A person who experiences one needle-stick injury from a needle used on an infected source patient has risks of 30%, 1.8%, and 0.3%, respectively, of becoming infected with HBV, HCV, and HIV.

Chemical, cytotoxic and radioactive waste are toxic, carcinogenic and genotoxic and causes severe imbalance to the existing ecosystem.

In the Indian subcontinent, the Central Pollution Control Board (CPCB) has established standards to guarantee proper BMW disposal. It is a statutory organization under the Ministry of Environment, Forest and Climate Change (MoEFCC) of India, established in 1974 under the Water (Prevention and Control of Pollution) Act. To ensure proper and optimized BMW management, CPCB established guidelines and rules to be followed by the medical facilities as well as the common BMW treatment facilities (CBWTFs) which has been amended from time to time.

In July 2020, the fourth revision of the guidelines was published, which included updates and modifications for separating general solid waste and BMW from quarantine canters, home care facilities, and hospitals treating COVID-19 patients, as well as recommendations for the disposal of PPE. Under the Act, healthcare facilities bear the responsibility of effective BMW management to ensure public health and environmental safety. This involves the segregation, proper collection, transportation, treatment, and disposal of BMW.

Existing Challenges and Concerns

Lack of awareness and training among health care workers and waste handlers with inadequate monitoring and inspection in health care facilities, inadequate infrastructure with lack of dedicated waste disposal units, insufficient waste collection systems, and limited treatment facilities, costs of supplies and materials used for collection, transport, storage, treatment, disposal, decontamination and cleaning and cost of training and contract services are major challenges faced in implementing good BMW disposal practices.

Solutions and Strategies for better management of BMW.

- Establishment of a Biomedical waste management and Infection Control team at Health care facilities.

Healthcare facilities should have a designated team for the proper management and disposal of BMW. The team should consist of a Infection control officer, Hospital project manager, Head Nurse, Clinical Pharmacist and Laboratory in charge.

The infection-control officer's duties include: Identifying training requirements according to staff grade and occupation organizing and supervising staff training courses on the infection risks from poor waste management liaising with the department heads, the matron, and the hospital manager to coordinate training activities and conducting regular inspection of BMW treatment and disposal practices. Clinical Pharmacist needs to monitor procedures for the treatment and disposal of pharmaceutical waste ensuring that personnel involved in pharmaceutical waste handling, treatment, and disposal receive adequate training. The pharmacist should remain up to date with the proper treatment and safe disposal of expired, damaged, and unusable pharmaceuticals, pharmaceutical packaging, and equipment. The Hospital manager should ensure stocks of consumables (bags, receptacles and containers, personal protective equipment, etc.) are permanently available. Head Nurse should ensure proper training to health care staff in waste management (paying special attention to new staff members) and monitor sorting, collection, storage and transport procedures in the various wards. A quarterly meeting should be conducted to discuss existing practices and issues related to Biomedical waste management.

- Use Modern Techniques in waste treatment : Modern techniques like high-temperature hydrothermal carbonization and autoclave pressure technology can be used to carbonize BMW. Different methods of disinfection such as hydrogen peroxide steam, washing, ultraviolet (UV) disinfection lamps, humidifiers, gamma radiation, alcohol solutions of 75%, and ethylene oxides can be considered

- Integrated Solid Waste Management Hierarchy (3Rs approach):Integrated Solid Waste Management Hierarchy, based on the concept of 3Rswhich includes prevention and reduction in the production of waste and minimize the quantity entering the waste system, re use and recycle waste after processing and recover waste items to generate fuel for electricity and direct heating, treat waste which cannot be recovered and finally dispose to landfill if no other option is available.
- Community engagement : A public awareness program and a media campaign must be launched to raise awareness of the environmental impact of accidental discharges and poor governance of plastic waste (PW) and BMW.

Conclusion

BMW disposal is pivotal for public health and environmental preservation. Adapting good infection control practices in the health care facility with continued compliance to best practices and government regulations in BMW treatment and disposal will ensure a sustainable future with minimized environmental and public health risks.

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Best Practices to Prevent Needlestick Injuries

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Introduction

Needles are unavoidable in healthcare settings, but needlestick injuries are preventable. A needlestick injury is a penetration of the skin by a needle or other sharp object that has been in contact with another person's blood, tissue, or other body fluid before the injury [1] (OSHA 2001; CDC 2011). Needlestick injuries (NSIs) remain a global threat, with an estimated 44.5% of healthcare workers experiencing at least one occurrence annually.

The World Health Organisation (WHO) reports that over 2 million occupational exposures among 35 million healthcare workers (HCWs) occur each year, making NSIs one of the most dangerous occupational hazards for HCWs worldwide.[3] (WHO, 2019).

Impact of needlestick injuries

Threat of contracting infection

In fact, after a needlestick injury, almost any organism can spread, although very few of these types are clinically significant. The most significant pathogens that may be contracted following a needlestick injury are hepatitis B, hepatitis C, and HIV.

According to CDC [4], the risk of transmission for bloodborne infections after needle-stick/cut exposure to infected blood is 0.3% for HIV, 2.7–10% for HCV and 6–30% for HBV [depending on the hepatitis B e antigen (HBeAg) status]

Economic implications

NSIs involve potential risks, upfront expenses for laboratory testing, treatment costs, post-exposure prophylaxis for registered nurses, and financial burdens for hospitals due to staff absences5. Following an NSI, significant expenses include testing for infection, post-exposure prophylaxis, short- and long-term treatment of chronic viral infections, staff absence and replacement, counselling for injured workers, and legal consequences [6]. An estimated $6.1 million in France and $118-591 million in the USA are spent annually on NSI diagnostics and treatments as of the year 2007. In Mumbai, India, a tertiary care hospital was paying around ₹ 9000 / HCW / episode for needlestick injuries as short-term costs as of the year 2010 which could be more costly considering the year 2023. [7,8,9]

Psychological implications

Needlestick injuries in healthcare settings can cause significant psychological distress, including fear of bloodborne infections like HIV or Hepatitis B, guilt, and self-blame. These injuries can lead to increased vigilance and hypervigilance, negatively impacting job performance and overall well-being. Healthcare organizations should prioritize providing support systems for individuals experiencing needlestick injuries, including counselling services and education on prevention strategies. Recognizing these implications and providing appropriate support systems is crucial to mitigate their long-term effects on mental health [10 ,11].

Impact on patient care

Needlestick injuries in healthcare workers can cause increased anxiety, stress, and absenteeism, leading to suboptimal patient care. This can result in a lack of continuity of care, disrupting effective patient management. Additionally, needlestick injuries increase the risk of bloodborne infection transmission, posing a direct threat to patients' health and undermining trust in the healthcare system. Therefore, it is crucial to address these issues to ensure patient safety.

Prevention of Needlestick injuries

Education and training

Training on needlestick injuries is crucial for healthcare professionals to prevent incidents and ensure safety. It educates workers about the risks of needlestick injuries, such as bloodborne pathogens, and equips them with practical skills to prevent them. Training also fosters a culture of safety within healthcare organizations, encouraging open communication and prompt reporting of incidents. Regular training leads to more consistent adherence to safe practices.

Administrative and Engineering controls

Use of safety-engineered devices that incorporate features like retractable needles or protective shields can significantly reduce the risk of accidental needlesticks. Employers must provide these devices and ensure their availability in all areas where sharps are used.

Types of sharps safety devices that can be used to protect workers:

- Needle-free IV systems
- Sheathed, blunting, or retractable needles
- Non-breakable plastic vacuum and capillary tubes
- Blood transfer adapters
- Sharps disposal containers

Studies show that needlestick injuries may have increased after the implementation of Special Safety Engineered Devices (SEDs), with the most common causes being difficulties in operating the device and improper needle disposal, contrary to the expected decrease in needlestick injuries [12]. So it is important that employers involve frontline workers in selecting devices with safety features and train them adequately on the use of SEDs.

Strict infection control practices

The prevention of needlestick injuries among healthcare workers is contingent upon strict adherence to infection control protocols. The risk of these injuries can be reduced by using safe needle handling practices, practicing good hand hygiene, donning personal protection equipment (PPE), and properly segregating and disposing of waste. Consistent implementation of these measures can create a safer environment for patients and staff members.

The "One and Only" campaign emphasising “one needle, one syringe and only one time” by the CDC is an essential initiative that aims to ensure safe injection practices in healthcare settings. By emphasizing the importance of using new needles and syringes for each patient, this campaign contributes significantly to preventing bloodborne infections. It serves as a reminder for healthcare providers to prioritize patient safety while administering injections.

Guidelines from Ministry of Health and Family Welfare, India to health care providers

When the use of sharp objects cannot be avoided, ensure that the following precautions are observed[13]:

- Never replace the cap on a used needle.
- Never direct the point of a used needle towards any part of the body.
- Do not remove used needles from disposable syringes by hand, and do not bend, break or otherwise manipulate used needles by hand.
- Never reuse syringes or needles.
- Dispose of syringes, needles, scalpel blades and other sharp objects in appropriate, puncture-resistant containers.
- Ensure that containers for sharps objects are placed as close as possible to the immediate area where the objects are being used (‘point of use’) to limit the distance between use and disposal and ensure the containers remain upright at all times.
- Ensure that the containers are securely sealed with a lid and replaced when ¾ full.
- Ensure the containers are placed in an area that is not easily accessible by visitors, particularly children.
- Closed, resistant shoes/footwear should be used by all individuals in the patient care area to avoid accidents with misplaced, contaminated sharp objects.

Recommendations of CDC for Healthcare Professionals

The following measures are recommended by CDC to prevent Needlestick injuries and to ensure sharp safety among healthcare professionals [14].

Be prepared

- Organize your work area with appropriate sharps disposal containers within reach
- Work in well-lit areas
- Receive training on how to use sharps safety devices
- Before handling sharps, assess any hazards–get help if needed

Be aware

- Keep the exposed sharp in view
- Be aware of people around you
- Stop if you feel rushed or distracted
- •Focus on your task
- Avoid hand-passing sharps and use verbal alerts when moving sharps
- Watch for sharps in linen, beds, on the floor, or in waste containers

Dispose of sharps with care

- Be responsible for the device you use
- Activate safety features after use
- Dispose of devices in rigid sharps containers; do not overfill containers
- Keep fingers away from the opening of sharps containers.

Culture of safety

A Facility's "culture of Safety" is important for sharps injury prevention and the facilities that value safety have fewer sharps' injuries. Characteristics of such facilities include:

- Sharps injury prevention is a prominent organizational priority
- Management and staff have a shared commitment to prevent sharps injuries
- Staff members are encouraged to report sharps injuries promptly
- Individual safety accountability is promoted

Conclusion

The prevention of needlestick injuries necessitates a multifaceted strategy that includes engineering controls, continuous monitoring, safety-engineered equipment, education, and training. We can successfully protect our committed healthcare professionals' well-being while delivering the best possible patient care by applying these best practices consistently across healthcare settings.

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> Technical guidelines addressing COVID-19 waste and verification protocols signify India's dedication to adapting to evolving healthcare challenges.

Challenges in waste segregation in resource limited rural hospitals

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Abstract

Biomedical waste management is a critical aspect of healthcare that significantly impacts the environment and the carbon footprint of the industry. The generation of biomedical waste is inherent in medical procedures and research, affecting both human and animal healthcare settings. Challenges in managing this waste include proper segregation, safe handling, timely transportation, and deposit to central treatment facilities, with variations in difficulties across urban, semi-urban, and rural areas. Rural regions often face greater hurdles due to longer distances to treatment facilities, inadequate training, limited resources for documentation, and the absence of specialized personnel like Infection Control nurses. This article explores the disparities in biomedical waste management across different healthcare settings and proposes solutions to address these challenges, emphasizing the need for equitable access to resources, training, infrastructure, and expertise in rural areas.

Introduction

Another important challenge would be ensuring the continuous handholding and support from the CBWTF that facilitates the proper biomedical waste management in urban and semi urban areas. This continuous interaction, positive reinforcement and critical feedback often serve as a driving force for continual compliance to the Biomedical waste guidelines.

On the other hand, the periodic visit of the institution to the CBWTF may also hampered by the inaccessibility, which may fuel the knowledge gap in the institution. The distant and sporadic collaboration would also leave space for unequal implementation of innovations in these rural institutions.

The required training of the healthcare providers by the CBWTF, which occurs as if clockwork in the urban and semi-urban settings, are often few and far apart in the rural settings, for obvious reasons. Continuous training and reinforcement are pivotal in biomedical waste segregation, as it is done at the point of generation, and wrong segregation puts the entire process at risk.

Lack of availability of trained manpower like Infection Control nurses in the rural scenario. The biomedical waste audit and housekeeping audit, which form part of the routines of infection control nurses, are pivotal in continual compliance with the guidelines and policies.

In rural settings, the availability of web, software and service provider support required for the automated documentation of daily, monthly, and annual reports of waste generation and transactions is often manual, long and drawn out.

An often-flourishing aspect of healthcare in the rural setting is the livestock and veterinary industry. A significant amount of biomedical waste is generated in the veterinary sector, and there exists much scope for improvement with respect to adherence to biomedical waste management guidelines.

Challenges

To address these challenges, we need to ensure that there are CBWTFs established evenly and with adequate spacing in the rural areas. The CBWTFs should be adequately manned and with all required expertise. Adherence to the recommended guideline of clearance once in 48 hours should be ensured. Similarly, periodic visits to the CBWTF should be encouraged to ensure a proper understanding of the processes involved, and the repercussions of wrongful practices. Periodic updates and reports of wrongful segregation, if any should also be ensured.

The need for software and IT infrastructure and correspondingly trained manpower should be ensured by the Local self-governing bodies, and the importance of the same should be communicated by key professionals in the state/ nation.

Provisions for recruitment of Infection Control nurses should be made nationwide, with prioritisation for rural settings, understanding the need for having these professionals to ensure continued compliance.

Measures should be in place to ensure the inclusion of veterinary medical facilities as an important stakeholder in the process. All aspects if biomedical waste management should be implemented and monitored as in the case of hospitals and dispensaries.

We cannot move towards a better tomorrow and better biomedical waste management, when a section of the country is unable to keep up. We should prioritise the process of building a good network of compliant healthcare facilities in the rural areas, for a wholesome approach to biomedical waste management.

Conclusion

The effective management of biomedical waste presents varying challenges across healthcare settings, with rural areas encountering distinctive hurdles due to geographical constraints, resource limitations, and inadequate expertise. To bridge these gaps, it is imperative to establish well-equipped treatment facilities evenly across rural regions, ensuring timely waste clearance and encouraging periodic visits for knowledge dissemination. Investment in IT infrastructure and documentation and compliance monitoring training is crucial and supported by local governing bodies. Moreover, recruiting and deploying Infection Control nurses in rural areas should be prioritized to maintain continual compliance with waste management protocols. Integrating veterinary facilities into the waste management framework and monitoring their adherence to guidelines is also pivotal.

Innovate, implement, impact: Shaping a greener tomorrow in healthcare

Challenges in waste disposal and treatment process in a common biomedical waste management facility

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Volume and scale

There is defined amount of waste to be segregated and handed over to the common treatment facility which is similar for all levels of hospital. Eg: primary, secondary, tertiary, and quaternary set up. It also includes private and government hospital. It is a challenge to fit all size in one. Managing these fluctuations efficiently requires flexibility in collection schedules and capacities.

Global pandemics or widespread health crises can significantly increase the volume of biomedical waste, putting additional stress on waste management facilities. Facilities need to be prepared to handle surges in waste during such events. Covid was one such example where huge waste was generated due to high utility of PPEs, so peak period can place a huge burden on CTF.

Public perception

Communities near hospitals are concerned about the presence and segregation of biomedical waste and its facilities installed in their vicinity due to fears of contamination and transmission of infection related to health risks. Public perception can lead to opposition, making it challenging to establish and operate BMW facilities.

Emergency response or preparedness

Collection personnel must be prepared to respond to emergencies, such as spills or accidents during transportation. Having robust emergency response plans in place and ensuring that collection staff are trained to handle unexpected situations is essential.

Timely collection

Timely collection is crucial to prevent the accumulation of biomedical waste at healthcare facilities. Delays in collection can pose health risks to staff and patients and may lead to non-compliance with regulations. Health care facilities are placed and spread across different locations, requiring efficient routing and scheduling for waste collection. Managing logistics to ensure timely pickups while minimizing travel time and costs can be a logistical challenge.

Monitoring, training, and enforcement

Larger sector of population on BMW training and monitoring their activities daily. Challenge to monitor BMW disposal process of common treatment facility as functioning begins late evening and continues till early morning.

Facility is situated at a distance away from the city zone, where monitoring becomes a challenge.

Only one facility handles waste for all the health care organization within 75km which leaves no choice for the organization to select their vendor.

Health care organization beyond 75km to the vicinity of BMW facility must discard BMW on their own.

Technology and infrastructure

Regular upgradation of treatment facility with newer technologies which can be expensive but can handle waste in more appropriate and easier way. It would also prevent outdated infrastructure which may lead to inefficient turn over.

Costs and financial constraint

Every BMW cover must be purchased from the same vendor right from the point of segregation to the storage in health care facility common storage area which incurs a huge cost constraint for the organization.

To establish and maintain a biomedical waste facility involves significant costs, including infrastructure development, technology acquisition, staff training, and ongoing operational expenses. Securing funding and managing costs effectively can be challenging.

Waste treatment residue

Byproducts or residue generated after treatment requires appropriate disposal. It requires a big space for safe disposal for environmental safety and may also involve huge cost.

Community engagement in Biomedical Waste Management

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While India has had a biomedical waste management rule since 1998, which was modified for ease in 2019, household biomedical waste has been neglected. The emergence of epidemics or pandemics, increased/better access to healthcare, early hospital discharge, increased lifespan, rise of non-communicable diseases and home management of chronic illnesses could all play a role in the rise in biomedical waste generation at home. The situation could get worse considering India's aging population and dependence on doorstep healthcare services. This poses serious challenges to a frail public health system. This growing problem needs to be tackled by acknowledging it, introducing guidelines, and decentralizing solutions, including facilitating recycling.

The market analysis for healthcare at home is predicted to expand from its current value of $179 million in 2022 to $295 million in 2030 at a compound annual growth rate (CAGR) of 6.40%. Environmental Research and Education Foundation (EREF) has revealed that between 2001 and 2011, the number of needles and sharps in household waste tripled.

Biomedical waste (BMW) is any waste produced during the diagnosis, treatment, or immunization of humans or during animal research activities or that produced in health camps. The above definition is often focused on the waste generated at hospitals, health institutions, research and training establishments, slaughterhouses, laboratories and biotechnology institutions while overlooking BMW generated at our homes.

Household biomedical waste (henceforth HBMW) usually gets mixed with other household waste in India, ending up in posing numerous public health hazards.

The clinical waste generated in households includes unused or expired medicines, used adult/baby diapers, soiled sanitary napkins, injected needles, bloodstained cotton buds, used condoms, spilt mercury, used band-aid, used X-ray films, pregnancy and blood sugar test strips, expired hand sanitizers and discarded insulin pens to name a few.

Wastes like these require sophisticated chemical processing plants, incinerators and disassembly centers for proper disposal. Unfortunately, conventional waste management infrastructure in developing countries is not efficient enough to handle or treat household biomedical waste. For example, when expired medicines are disposed of in sewage, our existing treatment plants cannot process them since they are not designed to break down pharmaceutical drugs. This eventually gives rise to superbugs and antimicrobial resistance.

Biomedical waste is hazardous and infectious. It has an impact on all biological life, not just people. The chemicals from the waste can pollute the air, water, and land. Needles, sharps, and lancets in household waste put municipal waste handlers at risk. If these needles or sharps are infected, a prick from them can cause blood-borne infections (HIV, Hepatitis C, and Hepatitis B).

One Health is an approach that recognizes and studies the interconnections between humans, animals, plants, and their shared environment. From the One Health standpoint, it is clear that biomedical waste has an impact beyond just humans.

How can community contribute in HBMW Management:

It's been observed in various studies that people are not aware about the hazards & management of Biomedical waste at home.Initiative can be taken to educate the patient attenders especially of bedridden patients & suffering from chronic illness who are responsible for generating HBMW in more quantities.

Community awareness can be in the form of short videos, pamphlets attached with patients discharge summaries or patients OPD Files or Short counseling session can be arranged for the attenders at the discharge time. On a larger platform, Hospitals can arrange a small outreach programs in public places to educate community or via social media.

2) Providing information on management of HBMW

Information regarding management of HBMW can be simplified & explained as per the waste generated as per the patient as follows:

Sharps: Lancets, insulin injection needles, and other sharp objects that can pierce the skin are called "sharps". People who take injections on a regular basis should have a sharps container in the house which is hard, thick plastic, and are constructed to be difficult to open (child and pet safe). Throw away syringes, with needles attached, into a sharps container immediately after use. Do not try to remove or bend the needle. Keep the sharps containers away from children. If sharps are produced regularly, it is worth buying a container or can make one from an old plastic bottle, or a metal container. Label it “SHARPS”. Do not use a cardboard carton or a container of thinner plastic, and try not to use a transparent container.

When the sharps container is full, put it in the regular trash. Put the sealed container into the center of a full, preferably dark trash bag and throw it out with the regular trash. Never put any type of sharp container in the recycle bin.

You might also have a hospital, clinic, or doctor's clinic nearby willing to take sharps waste for final disposal along with their BMW.

Cloth/ Disposable Items: Used cotton, gauze, gloves, diapers, sanitary pads and bandages may have blood, excreta, or other body fluids on them and hence be classified as infectious waste. Put them into plastic bags that can be sealed/knotted. When the bag is full or it is trash pickup day, seal the bag (to protect sanitation workers) and put it in the regular garbage pickup barrels.

Medicines: Prescription medicines should be used only by patients they are prescribed for. If you have leftover medicine you don't need, do not give it to someone else. Throw it away. DON'T FLUSH MEDICINES DOWN THE TOILET. Sewage treatment systems cannot typically break down drugs. For this reason, most drugs should be put in the regular trash barrel so your local authority picks it up for disposal in a landfill. The drugs are less likely to negatively impact the environment if they are in a landfill.

Radioactive/Chemotherapy waste:

Patients receiving radiation/chemotherapy such as brachytherapy and iodine treatment for thyroid disease can produce low-level radioactive waste. Their urine and feces may be considered radioactive. Follow your healthcare provider's instructions for cases like this. You might be advised to keep bodily wastes in a container for a while until the radioactive material decays.

3) Role of Hospitlals & Pharmacies:

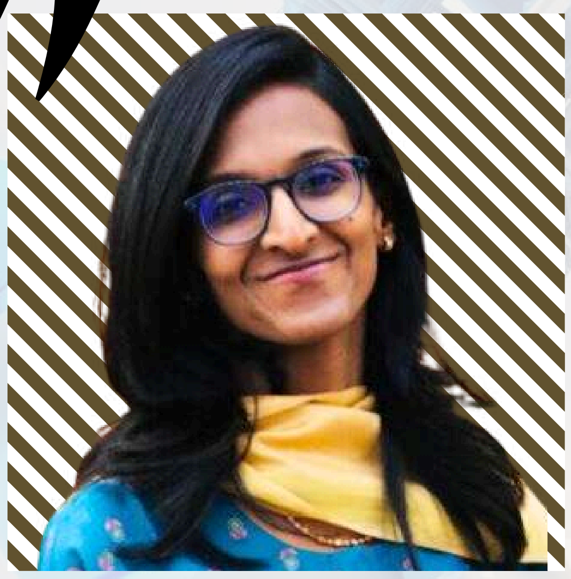
Hospitals/clinics where the patient is getting treated can give a facility of taking the BMW generated from the patients after proper counseling on its proper segregation & management. Healthcare providers who offer homecare and outreach services should be directed to take back any biomedical waste that was generated during the service delivery.

4)) Legislation and accountability

Since the effects of biomedical waste are multifaceted, the state governments should liaise with other important departments such as public health, pollution control board, urban local bodies, and other non-governmental organizations to streamline the management of household biomedical waste & issue proper guidelines for the same.Municipal waste handlers risk could be reduced by ensuring that they are provided with prick-proof gloves and boots, as well as Hepatitis B vaccination.

Australia, the United Kingdom (UK), and the United States of America (USA) are just a few countries that have begun sensitizing their citizens about ways to manage biomedical waste. The governments in India also should make efforts to disseminate scientific awareness materials to guide the public to take informed actions regarding Household biomedical waste disposal.

Internet of Things in Biomedical Waste Management



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Content

Biomedical waste(BMW) management in health care facilities necessitates effective strategies to mitigate the risk associated with it in terms of health hazards, environmental impact and to comply with the regulations. Improper management can lead to harmful outcomes affecting the environmental health. In India, an alarming amount of medical waste, 18,000 tons, was reported between June and September 2019, highlighting the severity of the issue. As healthcare industry is revolutionizing, there is an urgent requirement for making innovations in improving the efficiency, safety, and sustainability of the BMW management systems.

The Internet of Things (IoT) is an emerging technology with the potential to alter the waste collection industry completely. The IoT concept facilitates collaboration among humans, objects, and services within three-layered networks, eliminating the necessity for human intervention.

Real-time monitoring of waste

The World Health Organization (WHO) estimates that 40% of hepatitis and 2.5% of HIV cases around the world are caused by health professionals becoming exposed in the workplace. One of the main reasons is due to overfilling of waste bags leading to needle stick injuries. This can be avoided by using IoT sensors providing real-time information on the capacity of the bins. These ultrasonic embedded sensors continuously monitor the fill levels of these bins in real time. To ensure precise and accurate readings, these sensor employ the emission of sound waves, which measure the time taken for these waves to rebound and thus helps in determining the fill level. When a bin’s pre-set fill level surpasses the established threshold, an event is triggered within the cloud-based system. This information is then used to optimise waste collection and disposal and prevent it from being mishandled or disposed of improperly.

Radio Frequency Identification Technology

There is a huge manpower utilized in waste tracking in hospitals in terms of weighing, tagging, and using barcoding stickers in each bags as per the existing BMW guidelines. This can be avoided by using RFID coded bags i.e., Radio frequency identification technology.

To realize this application, a properly designed rugged RFID tag is attached to the waste bins. It contains all user/owner information. RFID reader collects the digital data and this encoded data is collected in database to track the process. An RFID reader/antenna embedded into the truck captures the tag IDs of each waste bin. The data collected from the RFID tags can be linked with a time stamp, type of container, weight of the container, and customer information. The data can be either sent to a host computer using wireless protocols or the data can also be stored in the truck on board computer and later transferred to a central waste management system for data processing.

Smart Bins Management System

The primary aim of this system is to introduce a waste sorting system that is streamlined. Using colour-coding simplifies the waste disposal process for users, making it easier to dispose of waste correctly as per the guidelines. It integrates cutting-edge sensor technology within the bins, facilitating automated garbage sorting. The proposed sensors can discern the type of discarded trash, diminishing users' need to manually select the appropriate bin and promoting the maintenance of a sanitary atmosphere. It gives real-time feedback mechanism that serves as an educational tool for users, fostering and reinforcing appropriate waste categorisation practices. It can gather data about the various types and volumes of waste. Subsequently, the collected data is transmitted to a centralised system or cloud-based database for analysis. The customisation of the colour-coding system based on the guidelines allows for its alignment with the regulations. Waste management authorities can remotely monitor the fill levels of the smart bins, optimising collection routes, reducing operational costs, and minimising environmental impact. This helps to maintain a sustainable environment. A mobile app can be used to monitor this process remotely.

Way Forward

Digitalization can offer even more benefits by minimizing manual work, mitigating data fraud, and preventing the misuse of waste. As digitalization advances, it is essential for all stakeholders to actively participate in monitoring waste management procedures to promote environmental health.

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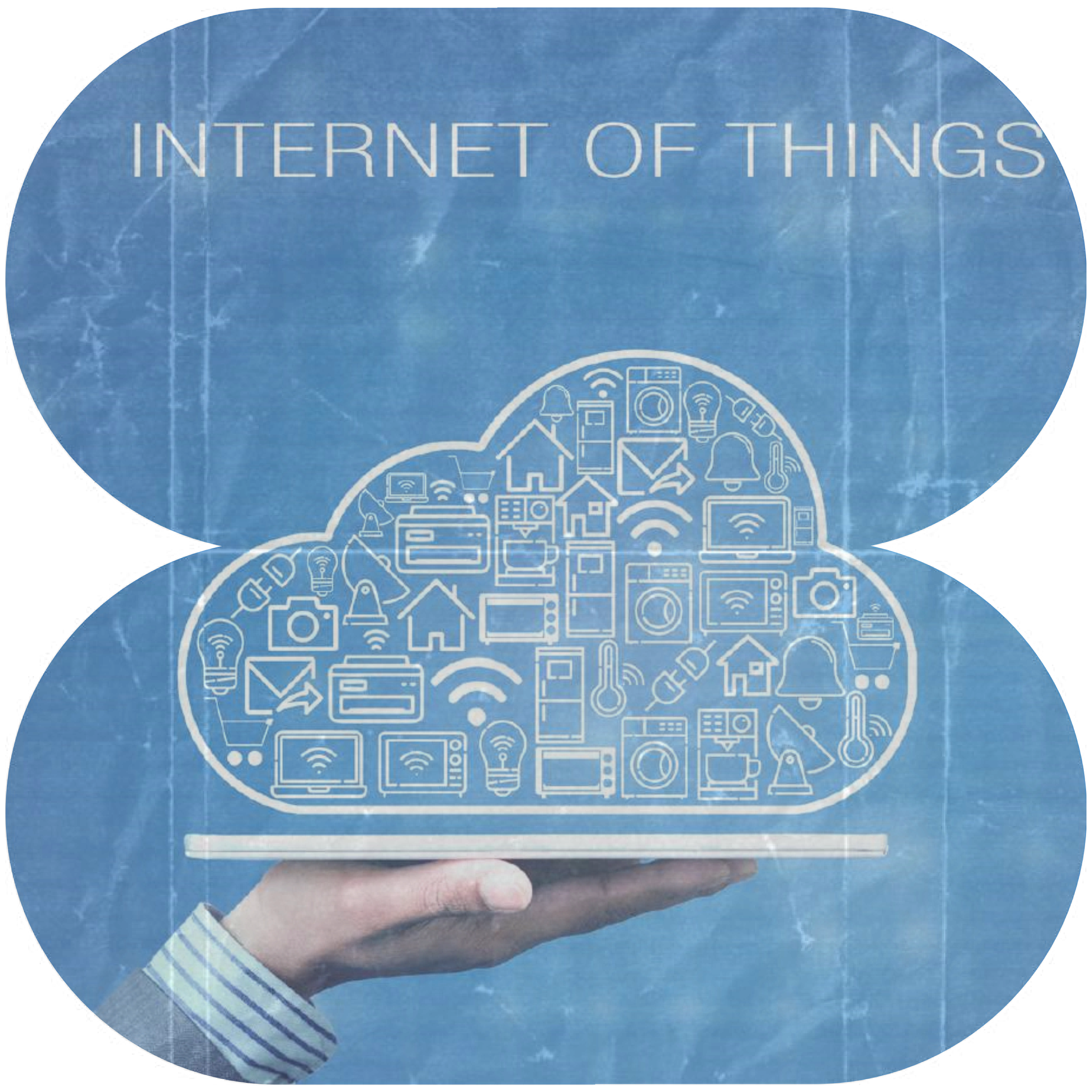

POV: Transforming Biomedical Waste Management in Indian Healthcare: Challenges, Innovations, and Collaborative Solutions

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Abstract

In the realm of healthcare, the management of biomedical waste stands as a critical yet intricate challenge. Recent discussions, notably in a pivotal session, have shed light on the multifaceted issues surrounding this matter, especially within healthcare facilities in India. Esteemed healthcare experts converged to dissect the challenges, innovations, and collaborative strategies to revolutionize biomedical waste management practices.

Challenges in Biomedical Waste Management

The discourse opened by addressing the complexities of waste generated in hospitals.

Categorizing into biomedical and general waste, the discussion outlined the diverse composition, highlighting categories like infectious, hazardous, plastic, glass, and general waste. Despite well-defined guidelines, practical challenges persist in daily operations.

Gray Areas and Information Dissemination

Participants highlighted a concerning lack of comprehensive information dissemination.

While social media inundates individuals with information, reliance on credible guidelines remains scarce. This gap often leads to confusion, with many resorting to online sources rather than official guidelines, underscoring the need for robust education from reliable sources.

Compliance and Technological Adoption

An ongoing challenge surfaces in the failure to adopt amendments in biomedical waste guidelines. The disparity between official guidelines and practices observed at waste treatment facilities further complicates waste segregation and disposal. The potential of technology emerged as a beacon, suggesting digital-based systems, telemedicine, and innovative waste treatment methods as pivotal solutions.

Collaborative Innovations and Economic Implications

The discussion didn’t merely dwell on challenges; it propelled innovative solutions and collaborations. Emphasis was placed on the role of technology, including microwave technology for waste treatment and reprocessing single-use devices to curb waste generation. Collaborative efforts between hospitals and communities were proposed, foreseeing mutual benefits in responsible waste management.

Policy-Level Interventions and Sustainable Practices

Policies and interventions were at the forefront, aiming to streamline waste management protocols, redefine waste handling, and introduce barcoding systems. It was highlighted that proper waste segregation not only contributes to cost-saving but also significantly diminishes carbon footprints, benefiting both hospitals and the environment.

Moving Forward: Unified Efforts and Holistic Approach

The consensus echoed a unified call for standardized guidelines, comprehensive training, and technological integration to overcome the challenges in biomedical waste management.

Suggestions for improvement included standardized training programs, technology integration for education and awareness, leadership engagement, and community involvement. The discussion culminated with a hopeful tone, anticipating increased awareness, improved guidelines, and collaborative efforts among stakeholders to usher in a transformative era in biomedical waste management across Indian healthcare facilities.

FAQs in Waste Management

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FAQ'S

1

What are the recent rules and guidelines for biomedical waste management in India? How do we access the guidelines?

The Biomedical waste management rules revised in 2016 with two key amendments made in 2018 and 2019 by the Ministry of Environment, Forest & Climate Change is the key legislation on BMWM in India. (can be accessed via https://cpcb.nic.in/rules-3/) These rules are supported by various guidelines, which can be accessed on the Central Pollution Control Board website. The website link is as follows: https://cpcb.nic.in/technical-guidelines-2

2

Where do we discard blood bags?

The blood bags should be pretreated at the hospital/laboratory/blood bank using a dedicated BMW autoclave. Thereafter it should be discarded in yellow bags to be sent to the common biomedical waste treatment facility (CBWTF)

3

Where do we discard vacutainers with blood?

The vacutainers with blood should be pretreated at the source (hospital/laboratory) using a dedicated BMW autoclave. These should then be placed in regular red bags in the laboratory to handed over to the CBWTF.

4

What is the rationale for discarding blood bags in yellow but urobags in red?

As the blood bags are highly infectious & and a source of organism multiplication, they need to be pretreated before being sent to the CBWTF. It could be that blood may have an unknown pathogen which is not easily destroyed with only autoclaving (e.g. prions) Hence it is best considered incinerated (even though blood bags are made up of chlorinated plastic). Urobags on the other hand have predictable organisms mostly bacteria or other pathogens that can be easily destroyed by sterilization alone. Hence, they are discarded in the red bag.

5

What is the colour coding used to discard ECG leads?

There is no mention of ECG leads in particular in the CPCB BMW guidelines. Based on the material seen in the ECG lead, most of the material belongs to the yellow category. Hence yellow may be chosen to discard ECG leads. But some follow blue owing to the metal component & and even some follow red. If you have a reason specific to any other colour coding (Eg: Red, Blue), you can add it to your hospital policy document it and communicate it to your CBWTF (third party).

6

Where do we discard expired medicine?

The expired medicine should be discarded in yellow-coloured bags separately.

FAQ'S

7 **Is it mandatory to cut the needles before discarding them in the white transparent puncture-proof container?**

It is not mandatory to cut the needles using a needle cutter/destroyer. The needles can be discarded separately in the white puncture-proof container and the syringes are to be discarded in red-coloured bags. If you practice cutting the needle, then needle should be discarded in white and the remaining hub should be discarded in red.

8 **Is it necessary to treat the biohazard wastes (Eg: HIV reactive) separately?**

No need, all wastes should be considered as hazardous and should be treated with utmost precautions.

9 **How do we discard empty lignocaine gel tubing?**

If the tubing is made of plastic, discard it into red coloured bag and if it is of metal, then discard it into blue coloured container.

10 **How to discard guide wires?**

It should be discarded in a blue puncture-proof container of an appropriate size

11

What is the exact method to discard chemotherapy wastes? Does all the consumables (Eg: Mask, gloves) go into yellow with C symbol?

As per the BMW rules 2016 and the available evidence, all the wastes generated during the preparation or mixing of chemotherapy agents should go into yellow with C symbol irrespective of the material type. (Ref: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5582558/)

12

Where do we discard the liver biopsy needle, and trucut biopsy needles with lengthy sharps?

It should be discarded in a white translucent puncture-proof container of an appropriate size.

13

How long can we store biomedical waste in a hospital setting? Is it for all the colour-coded categories of waste?

In the previous BMW Rules 1998, it was mentioned that “no untreated bio-medical waste shall be kept stored beyond a period of 48 hours”. But in the 2016 Rules, the clause was changed and only a few categories were put under this clause. BMW Rules 2016 says that “untreated human anatomical waste, animal anatomical waste, soiled waste and biotechnology wastes (Yellow Bags wastes) shall not be stored beyond a period of forty –eight hours”. Hence the sharps waste, and metal wastes can be discarded once the containers are ¾ filled. Thus, effectively the 48-hour clause is only for yellow bag waste. But efforts should be made to remove and treat waste as early as possible.

14

Is it mandatory that the mercury should be phased out?

Yes, it is mandatory that the mercury should be phased out. It is a hazardous waste (Reference: 2016/H/16/3, New Delhi Lr dated 29.06.2016). All the devices (Eg: BP apparatus, thermometer) that use mercury should be phased out and replaced with non-mercury alternatives.

15

Where do we discard blood sugar strips and other rapid test strips?

All strips made of plastic should be discarded in red-colour bags

16

How do we discard chemical wastes generated in the laboratory (Eg: Formalin, Glutaraldehyde)

These chemicals need to be neutralized with appropriate neutralizers and then disposed in the drains connected to hospitals effluent treatment plant (ETP).

17

How to dispose of ethylene oxide (EO) cartridges?

EO cartridge discarding can be discarded safely in red bag as it is a non-incinerated waste. Do not puncture or incinerate unused cartridges. Aerate empty cartridges according to instructions in the equipment manual. After aeration offer for recycling or disposal of as non-incinerated waste (Red colour).

18

How do we discard cautery cable?

Cautery cable is discarded in red-colour bags.

19

Who is responsible for the barcoding? Is it the occupier or the common treatment facility centre?

It is the occupier who is responsible for the barcoding of the waste bags. However, the barcoded bags can be procured from the CBWTF based on the MOU drawn between the hospital and the third party. In some states, the barcoding is done by the state pollution control board. Hence discuss with your local SPCB and CBWTF.

20

What is the policy for disposal of battery wastes?

The battery wastes should be collected separately and should be auctioned or should be given back to the manufacturer/vendor Battery waste comes under the Battery Waste Management Rules 2022.

The link is given below
https://cpcb.nic.in/uploads/hwmd/Battery-WasteManagementRules-2022.pdf

It is the duty of the consumer to discard Waste Battery separately from other waste streams and to ensure that they are given to an entity engaged in collection refurbishment or recycling.

21

Is it mandatory to weigh in each ward/ICU or can we weigh the BMW wastes for the entire hospital together?

There is no defined rule for where the weighing should take place. The bags can be pasted with a label that has specifics like the area where the waste originated from. Then the hospital staff posted in temporary storage area can weigh and keep a note of ward-wise data. As weighing is helpful to trace back the overutilization of consumables, ward-wise weighing will help to do an analysis of the BMW waste exceeds the general norm of per bed generation.

22

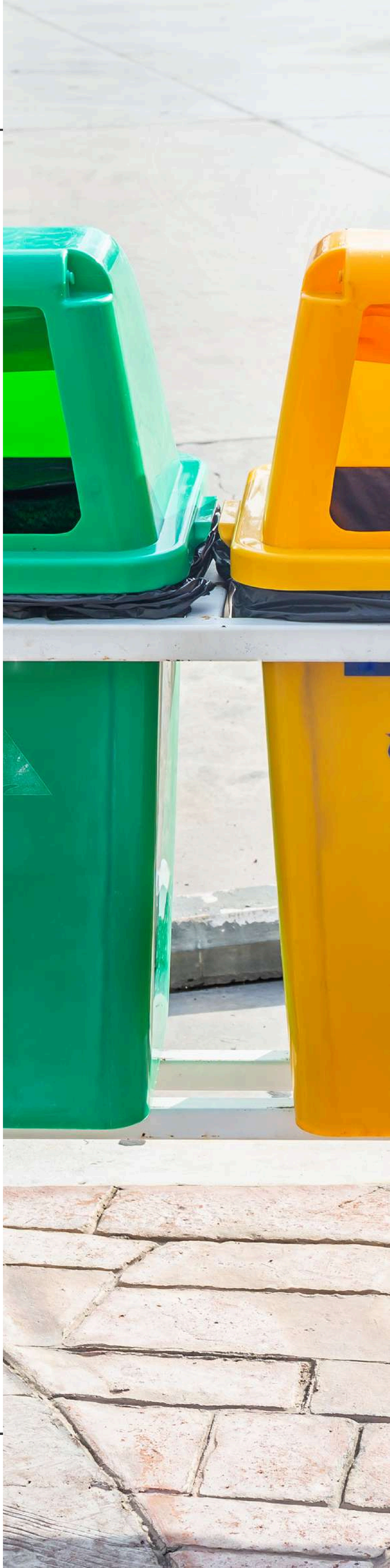
What is the colour coding for e-waste?

E- waste is covered under the E-waste Management Rules 2022. Bulk consumers of electrical and electronic equipment listed in Schedule I shall ensure that e-waste generated by them shall be handed over only to the registered producer, refurbisher or recycler of this waste. (can be accessed via https://cpcb.nic.in/uploads/Projects/E-Waste/e-waste_rules_2022.pdf)

23

How long can we store the diluted (1%) Sodium hypochlorite solution?

The diluted and freshly prepared 1% sodium hypochlorite can be used for a maximum of 24 hours. Alternatively, chlorine (NaDCC) tablets can be used.



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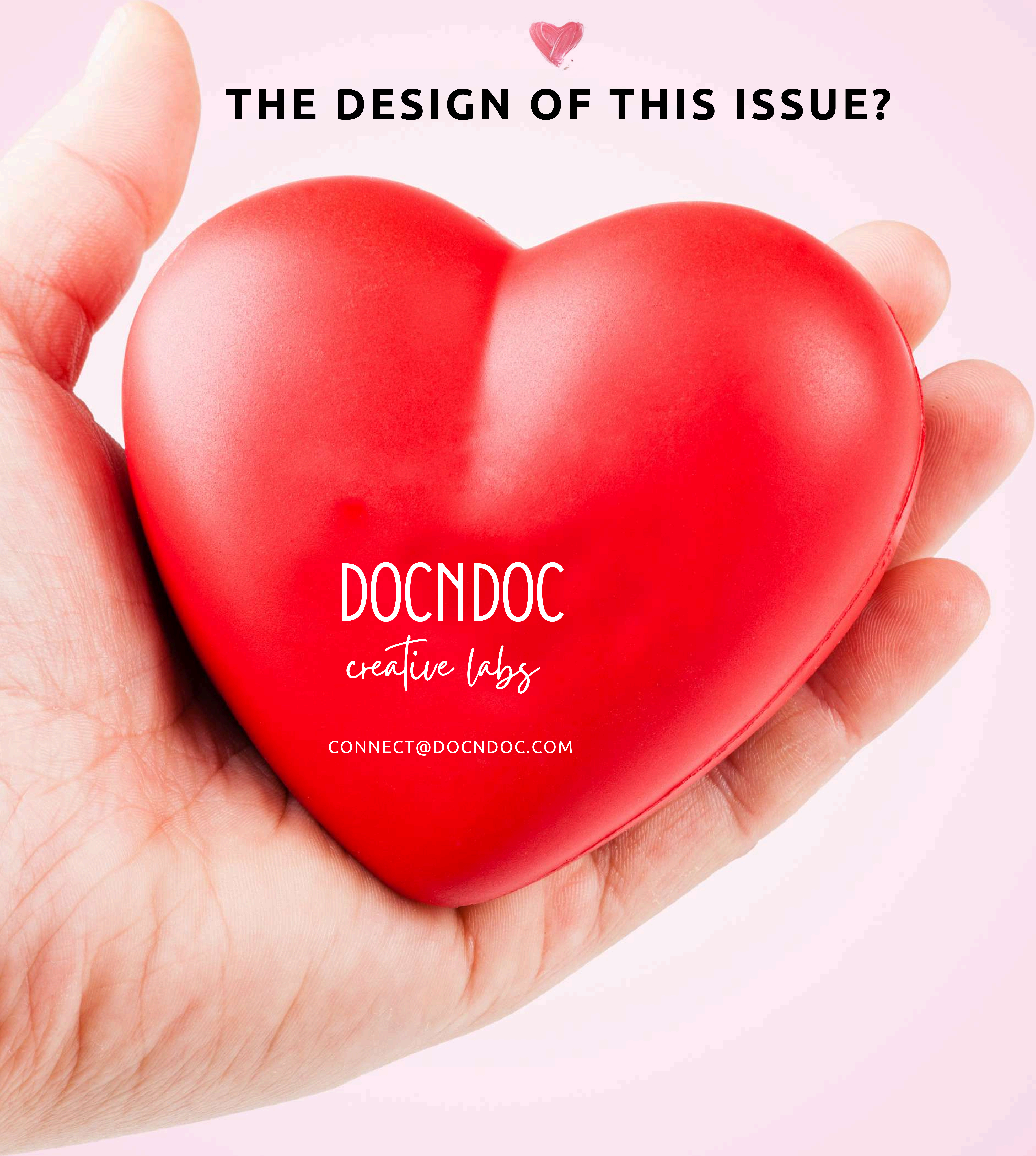

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