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Evaluation of Waste Management Practices in Healthcare Establishments in Khulna City

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Abstract
Healthcare waste management poses a growing public health and environmental challenge in Bangladesh, with specific concerns cantered around Khulna city, which is third largest city having 59.57 square kilometers and the whole district covers almost 4394.46 square kilometers. This research paper presents an assessment of waste management practices in healthcare establishments within the city. The study investigates healthcare waste management in both public and private establishments of selected main 11 healthcare centers where this city have 406 health-care or diagnostic center, estimates total medical waste production based on patient capacities, evaluates the overall waste management cost, and emphasizes the significance of medical waste management while exploring eco-friendly options. The methodology includes a comprehensive analysis, data tables, and a comparison of the present and proposed medical waste management systems.

Keywords: Healthcare Waste Management, Public Health, Environmental Challenge, Bangladesh, Khulna City, Waste Management Practices, Public and Private Establishments of Healthcare Centers, Healthcare or Diagnostic Centre, Medical Waste Production, Waste Management Cost, Significance, Eco-friendly Options, Comprehensive Analysis, Medical Waste Management Systems

1. Introduction

Healthcare waste management is a critical concern for both public health and environmental sustainability. Proper disposal and management of medical waste are essential to prevent health hazards and reduce environmental pollution. This research focuses on assessing the current waste management practices in healthcare establishments within the city, with a specific emphasis on public and private healthcare facilities. Access to healthcare is recognized globally as a fundamental human right. International declarations and national constitutions affirm this right, emphasizing the duty of states to ensure the well-being of their citizens. However, the increasing trend of urbanization worldwide has led to the proliferation of healthcare facilities, generating substantial volumes of healthcare waste. This waste poses significant threats to public health and the environment. Improperly managed healthcare waste can transmit infectious diseases, endangering both healthcare workers and the community. Shockingly, millions of hepatitis B, hepatitis C, and HIV infections occur annually due to the unsafe disposal of items like syringes. The global impact of waste-related diseases is staggering, with millions of lives lost each year (WHO, 1999). In this context, Agenda 21, adopted in the United Nations Conference on Environment and Development, set

ambitious goals for waste management in cities, recognizing the urgent need for action. Unfortunately, the expansion of healthcare facilities in Bangladesh and many other developing nations has outpaced the establishment of effective waste management systems. Inadequate disposal practices, including mixing healthcare waste with household waste, create a hazardous situation. Bangladesh is not exempt from this challenge. The prevalence of diseases transmitted through healthcare waste, such as hepatitis B and HIV/AIDS, is alarming. While cases of HIV/AIDS in Bangladesh remain lower than in neighboring countries, they are on the rise (Sinha, 2004). Most troubling is the fact that healthcare waste, including syringes and needles, often ends up in the hands of those who resell these items, despite the grave health risks involved (Eco-access, 2004). Healthcare waste management has remained a neglected aspect of Bangladesh's healthcare system. Recent studies, primarily focused on Dhaka, have highlighted the lack of proper handling and disposal methods for medical waste. The rapid growth of the private healthcare sector has exacerbated the problem, affecting not just metropolises like Dhaka but also larger cities such as Khulna. Sadly, Khulna, the third-largest city in Bangladesh, is grappling with the consequences of inadequate healthcare waste management. This research focuses on assessing the current waste management practices in healthcare establishments within the city, with a specific emphasis on public and private healthcare facilities and explore sustainable, eco-friendly waste management solutions. Urgent action is needed to rectify this situation as urbanization continues at a relentless pace, posing grave threats to both the environment and the health of Khulna's residents. The primary objectives of this study are as follows:

- To investigate healthcare waste management practices in selected public and private healthcare establishments in the city.
- To estimate total medical waste production based on the patient capacities of the selected healthcare facilities.
- To assess the overall waste management cost, including waste reuse and associated authority expenses.
- To emphasize the significance of medical waste management and explore eco-friendly waste disposal options.

2. Methodologies

Conceptualization of the Research

The research begins with a clear conceptualization of the study's objectives and scope. This foundational step involves defining the key research questions and the specific focus on hospital waste management in Khulna City Corporation (KCC).

Literature Review

A comprehensive literature review is conducted to explore existing knowledge, theories, and best practices related to hospital waste management. This review provides valuable insights to inform the research process.

Selection of Health Care Establishments

The selection of health care establishments (HCEs) within Khulna City Corporation is a crucial aspect of this study. Careful consideration goes into choosing a representative sample of hospitals, clinics, and diagnostic centers.

Field Survey Design and Data Collection Planning

A robust field survey design is developed to collect primary data. This includes planning for data collection methods, sampling techniques, and survey tools.

Consultation (Before Data Collection)

Consultations are held with relevant stakeholders, including healthcare facility representatives and waste management authorities, to ensure alignment with research objectives and to establish cooperation.

Building Rapport with Respondents

Building rapport with respondents is a critical step to facilitate data collection. Establishing trust and understanding is essential for obtaining accurate information.

Data Collection

Data collection encompasses both primary and secondary data sources:

- ❖ Primary Data: Collected through instrumental surveys and questionnaire surveys from various stake-holders such as patients, administration, nurses, technicians, cleaners, and doctors.
- ❖ Secondary Data: Sourced from journal reports, non-governmental organizations (NGOs), the Depart-ment of Environment (DOE), KCC records, and other relevant sources.

Data Analysis

Collected data are subjected to rigorous analysis. Quantitative data from surveys and qualitative data from secondary sources are processed and interpreted to draw meaningful insights

Suggestion of Experts and Correction

The research benefits from expert input to validate findings and offer suggestions for improvement. Corrections are made as needed to ensure the research's validity and accuracy.

Final Report Preparation

The final report is meticulously prepared, incorporating all findings, data, analysis, and expert recommendations. It is structured to provide a coherent narrative of the research process and outcomes.

Report Presentation

The research findings are presented through a well-structured report that is accessible to stakeholders and decision-makers. This presentation phase is critical for disseminating the research's outcomes and encouraging informed action.

These methodologies ensure a systematic and rigorous approach to investigating hospital waste management in Khulna City Corporation. They encompass various data collection techniques and expert input to provide a comprehensive understanding of the issue.

Result And Discussion

Data Collection

The research methodology involved data collection from a variety of healthcare establishments within the city. Data related to waste generation, disposal practices, and costs were collected through surveys,

interviews, and site visits.

Figure 1: Collection of Waste in a Private HCE

Present Disposal Scenario of Medical Waste

This section presents the current disposal practices of medical waste in the city's healthcare establishments. It includes information on waste segregation, collection, transportation, and disposal methods.

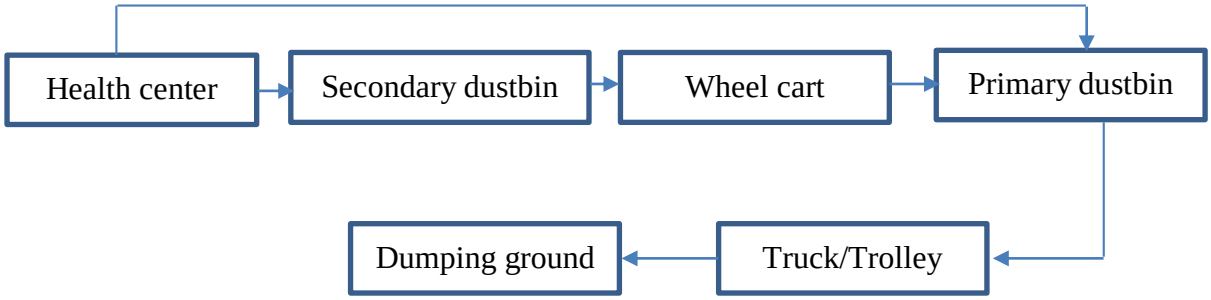

Figure 2: Flow Diagram of Disposal Method of Waste by KCC

Inventory of Different Health Care Establishments (HCEs)

A comprehensive inventory of various healthcare establishments, including hospitals, clinics, and diagnostic centers, is provided in this section. The inventory includes data on the types of establishments, bed capacities, and waste generation rates.

Table 1: List of Health Care Establishments Surveyed

SL. No.	Health Care Establishments	No. of bed	Category
01	Khulna Sadar Hospital (KSH)	250	Government
02	Khulna Medical College & Hospital (KMCH)	1000	Government
03	Shaheed Sheikh Abu Naser Specialized Hospital (SSANH)	400	Government
04	Khulna Shishu Hospital (KSH)	200	Private
05	Gorib Newaz Clinic & Diagnostic Center (GNCDC)	50	Private
06	Islami Bank Hospital (IBH)	50	Private
07	Khulna Surgical & Medical Hospital Pvt. Ltd (KSMH)	100	Private

08	Khalishpur Clinic (KC)	25	Private
09	Khulna City Medical College Hospital (KCMCH)	100	Private
10	City Imaging Center (CIC)	25	Private
11	Padma Diagnostic Center (PDC)	30	Diagnostic center

Table 2: Chemical Characteristics of Healthcare Waste (Roteb, 1998)

Waste	Component	Moisture (%)	Incombustible Solid (%)	Heating Value (MJ/kg)
Type no. 1	Rubbish and garbage	50	7	10.4
Type no. 2	Wet waste of hospital	70	5	6.2
Type no. 3	Pathological waste of hospital and laboratory	85	5	2.1

Composition of Healthcare Wastes:

The wastes generated in health care establishments is extremely heterogeneous in composition; however it can be generally described as a mixture of paper and cardboard, plastic, pathological waste, food waste, glass' and metal. Factors affecting the amount of these elements present in the waste stream include the extent of laboratory/research activities, use of disposable, and the rate of surgeries scheduled.

The approximate compositions of various wastes generated in health care establishments arc shown in table

Table 3: Waste Composition (Cross et al., 1990)

Types of Operation	% Paper	% Plastic	% Pathological	% Food waste	% Glass	% Metal	% Other
Administrative/ Clerical	100	-	-	-	-	-	-
Cafeteria	20	20	-	60	-	-	-
Surgery	60	30	10	-	-	-	-
Emergency Room	60	35	5	-	-	-	-
Intensive Care	60	35	5	-	-	-	-
Renal Dialysis	10	85	5	-	-	-	-
Laboratory	35	30	25	-	10	-	-
Nursery	45	35	-	5	15	-	-
Pharmacy	50	30	-	-	20	-	-
General Patient Care	60	35	-	5	-	-	-
Research	50	-	30	-	-	-	20*

Sharps	-	90	-	-	-	10	-

Comparative Analysis of Medical Waste Generation (%)

This section presents a comparative analysis of medical waste generation percentages in the studied healthcare establishments. It highlights variations in waste generation rates among different types of healthcare facilities.

Table 4: Generation Rate of Healthcare Waste in the Study Area

No.	Hospitals / Clinic/ Diagnostic Center	Total generated waste(kg)/ bed/day	Mean kg/bed/ day	Haz. Waste (kg)/bed/ day	Mean kg/bed/ day	% Hazardous	% General Waste
1	KMCH	0.68		0.14		25.5	74.5
2	KGH	0.83		0.2		22.32	77.68
3	KSH	0.65		0.12		18.7	81.3
4	IBH	1.15		0.2		14.97	85.03
5	GNCDGHC	1.3		0.24		19.10	80.89
6	KSMH	0.14	0.64	0.3	0.18	19.1	80.9
7	CIC	1.3		0.23		18.8	81.2
8	SSANSH	1.5		0.23		25.35	74.65
9	KC	1.13		0.2		19	81
10	PDC	0.27		0.08		32.3	67.7
11	KCMCH	0.63		0.12		19.4	80.6

Table 5: Different Categories of Healthcare Waste (% by weight) in Study Area

HCEs	General	Infectious	Reusable	Sharps
KGH	74.5	19	3.84	2.66
KMCH	77.68	17	2.5	2.82
KSH	81.3	16	1.2	1.5
IBH	85.03	12	1.5	1.47
GNCDGHC	80.89	13.65	2.5	2.96
PDC	67.7	18	9	5.3
KSMH	80.9	13	3.1	3
CIC	81.2	13.2	2.8	2.8
SSANSH	74.65	20	2.35	3
KC	81	15	2.51	1.49
KCMCH	80.6	12	3.4	4
% of Haz. and Non- hazardous waste	78.67	15.35	3.15	2.81

Table 6: Hazardous Waste Generation in Various Countries (UN Statistics Division. 2011)

Name of the Country	Generation of Hazardous Waste (1000 tonnes)
Bangladesh	75.9[5]
China	14300
France	2.4[7]
India	8140
Japan	2883
Russian Federation	141019.1
UAE	272.9[22]
USA	34788.4[25]

Table 7: Bangladesh health facility distribution by division and health facility type (SPA28)

Division	CC	USC/RD	UHFWC	UHFWC	UHC	MCWC	DH	NHSDP	Other	Hospital	PH	Total
Barishal	1061	58	208	28	34	10	6	14	34	1	13	1467
Chattogram	2400	238	468	203	89	18	11	101	55	0	164	3747
Dhaka	2431	308	422	184	75	14	14	114	167	3	215	3947
Khulna	1640	133	345	99	51	14	10	50	44	1	47	2434
Mymensingh	1147	114	195	45	30	4	3	20	22	0	14	1594
Rajshahi	1900	321	378	40	61	13	7	33	60	0	42	2855
Rangpur	1777	198	306	71	50	12	7	33	26	0	34	2514
Sylhet	855	75	114	86	31	6	4	33	15	0	34	1253
Bangladesh	**13211**	**1445**	**2436**	**756**	**421**	**91**	**62**	**398**	**423**	**5**	**563**	**19811**

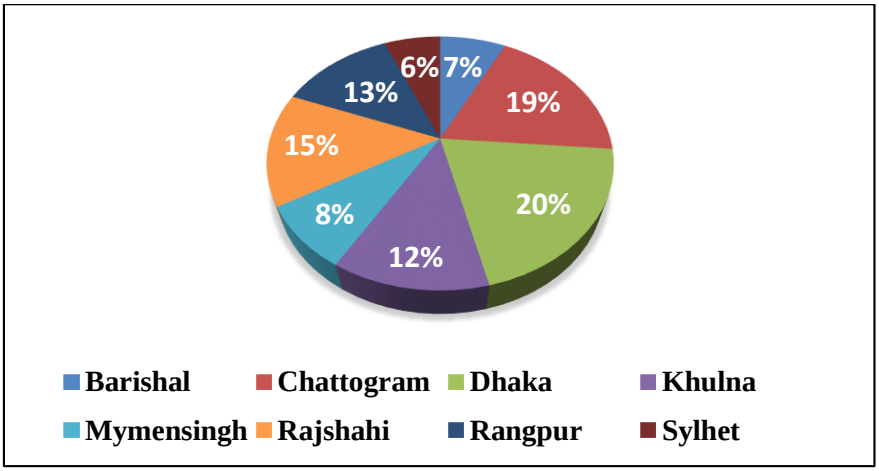

Figure 3: Bangladesh health facility distribution by division and health facility type (SPA28)

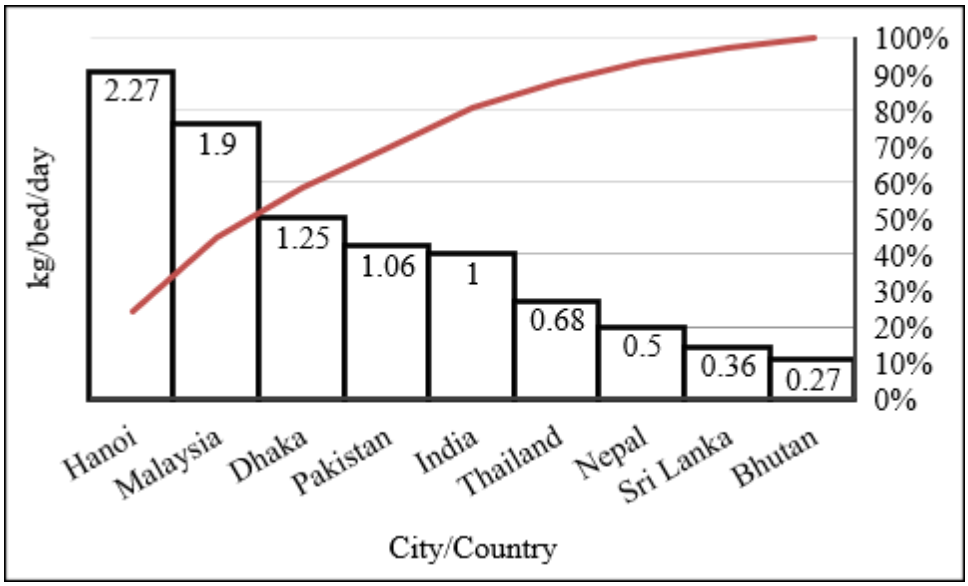

Figure 4: Estimated Avg. Healthcare Waste Generation in a Few Asian Countries/Cities (Visvanathan, 2006)

Country	Location	No. of facilities	Waste (kg/bed-day)	Reference
China	Nanjing	15	0.68	Yong et al., 2009
China	Shandong	23	0.6–1.5	Gai et al., 2009
China	Gansu	74	0.59–0.79	Zhang et al., 2013
China	Binzhou	6	0.77–1.22	Ruoyan et al., 2010
Lao PDR	Vientiane/Bolikhamxay	21	0.38–0.62	Phengxay, 2005
Serbia	Nisava/Tropica	3	1.9	Stankovic et al., 2008
Turkey	Istanbul	192	0.63	Birpinar et al., 2009
Turkey	Trachea	465	0.28–0.82	Uysal, 2004
Turkey	Sivas	4	1.25–2.6	Altin et al., 2003
Iran	Fars	15	4.45	Askarian et al., 2004b
Iran	Tabriz	10	3.48	Taghipour and Mosaferi, 2009b
Iran	Tehran	6	2.3–3.0	Arab et al., 2008
Iran	Tehran	12	4.42	Dehghani et al., 2008
Iran	Tehran	8	2.75	Farzadkia et al., 2009
Iran	Sistan/Baluchistan	14	2.76	Bazrafshan and Mostafapoor, 2011
Iran	Ahvaz	1	3.79	Hadipour et al., 2013
Jordan	North	4	1.88–3.49	Bdour et al., 2007
Jordan	North	21	0.83	Abdulla et al., 2008
Palestine	Nablus	4	0.59–0.93	Al-Khatib et al., 2009
Egypt	El Beheira	8	0.85	Abd El-Salam, 2010
Sudan	Khartoum	8	0.87	Saad, 2013
Algeria	Mostaganem	10	0.83	Bendjoudi et al., 2009
Ethiopia	Hawassa	9	3.46	Israel Deneke et al., 2011
Nigeria	Lagos	4	0.57	Longe and Williams, 2006
Mauritius	Port Louis/North	3	0.37–0.49	Mohee, 2005
El Salvador	San Salvador	1	0.37	Johnson et al., 2013
Brazil	Sao Carlos	1	1.07	Mattoso and Schalch, 2001
Brazil	South	91	3.24	Da Silva et al., 2005
India	Belgaum	1	0.50	Patil and Pokhrel, 2005
India	Lucknow	1	0.5	Gupta and Boojh, 2006
India	Lucknow	8	0.56	Manar et al., 2014
India	Karnataka	3	0.16–0.56	Onursal, 2003
India	Maharashtra	14	0.08–1.04	Onursal, 2003
India	West Bengal	8	0.19–0.51	Onursal, 2003
Bangladesh	Dhaka	69	1.58	Syed et al., 2012
Bangladesh	Chittagong	1	1.28	Md Maksud et al., 2008
Pakistan	multiple	78	2.0	Khattak, 2009
Pakistan	Gujranwala	12	0.67	Ali et al., 2016d

Figure 5: Healthcare Waste Generation in Various Countries

Treatment Processes in Different Sectors

A detailed description of the treatment processes for medical waste in various sectors, such as hospitals and clinics, is provided. This includes information on methods such as incineration, autoclaving, and microwaving.

Medical Waste Treatment in Different Sectors

Hospitals and Healthcare Facilities:

- Autoclaving: Steam-based sterilization to render waste non-infectious
- Incineration: High-temperature burning to reduce waste volume.
- Chemical Treatment: Using disinfectants or chemicals to treat waste.
- Segregation: Separating infectious waste from non-infectious waste.

Municipal Waste Management:

- Landfill Disposal: Safe burial of treated medical waste in designated landfills.
- Recycling: Segregating recyclable materials from medical waste.
- Composting: Transforming organic medical waste into compost.

Non-Governmental Organizations (NGOs):

- Collection and Transportation: NGOs often collect waste from healthcare facilities.
- Centralized Treatment: Large-scale treatment facilities for comprehensive waste management.
- Segregation and Sterilization: Ensuring safe handling, sterilization, and disposal.

Infectious Waste Treatment:

- Incineration: High-temperature burning for complete sterilization.
- Microwave Treatment: Heat-based treatment to kill pathogens.
- Chemical Disinfection: Using chemicals to neutralize infectious agents.

Recyclable Waste Management:

- Collection and Sorting: Identifying recyclable materials (e.g., plastics, glass).
- Cleaning and Shredding: Preparing recyclables for processing.
- Recycling Facilities: Facilities that process recyclables into new products.

Sharp Waste Disposal:

- Encapsulation: Secure containment of sharp waste for safety.
- Burial Pit Treatment: Safe disposal in dedicated burial pits.

Environmental Considerations:

- Eco-Friendly Practices: Promoting waste reduction, recycling, and sustainability.
- Pollution Control: Measures to prevent air, soil, and water pollution during waste treatment.

Legal and Regulatory Compliance:

- Adherence to local and national regulations for safe waste management.
- Licensing and Monitoring: Oversight by government authorities to ensure compliance.

Public Awareness and Education:

- ❖ Informing healthcare workers, waste handlers, and the public about safe practices.
- ❖ Encouraging proper waste segregation and disposal.

This overview outlines various medical waste treatment methods employed in different sectors to ensure the safe and environmentally responsible management of healthcare waste.

Disposal

This section outlines the final disposal methods used for medical waste, including landfilling, recycling, and eco-friendly disposal options. It evaluates the environmental impact of different disposal practices.

Figure 6: Photograph Showing Final Disposal Site of Waste at Rajbandh of Khulna City

Cost Analysis

Officer-	01
Officer (Part-time)-	01
Supervisor-	02
Collector-	06
Total-	10

Carriage System

Covered Van-		02
Plastic Dram (Big)-	14	
Plastic Dram (Small)-		04

Monthly Total Expense TK-1,65,000.
Yearly Expense TK-1,65,000*12= TK 19,80,000
Source By Pradipan

Comparison of Present and Proposed Medical Waste Management System

This section compares the existing medical waste management system with a proposed system that incorporates eco-friendly waste disposal options. It assesses the potential benefits of adopting more sustainable practices.

Present management system

Existing Medical Waste Management Process

Healthcare Establishments (HCEs):

- ❖ HCEs generate medical waste during daily operations.

Temporary Storage:

- Medical waste is temporarily stored in large bins, divided into two sections:
  - Municipal Dustbin near Hospital Boundary
  - Collection by NGO (Non-Governmental Organization).

Collection by NGO:

- An NGO specializing in waste management collects medical waste from healthcare facilities.

Transportation by NGO:

- The collected waste is transported by the NGO to a central treatment facility.

Segregation:

- At the treatment facility, waste undergoes segregation into different categories:
  - General Wastes
  - Infectious Wastes
  - Recyclable Wastes
  - Sharp Wastes

General Wastes:

- General waste may be further processed through:
  - Dumping (Landfill)
  - Composting (if suitable).

Infectious Wastes:

- Infectious waste is subjected to treatment that may include:
  - Air Drying
  - Burning
  - Ash Generation
  - Final Disposal of Ash.

Recyclable Wastes:

- Recyclable waste is prepared for recycling through steps like:
  - Cleaning
  - Shredding
  - Final Disposal (if recycling is not feasible).

Sharp Wastes:

- Sharp waste is managed through:
- Encapsulation for safety
- Burial Pit Treatment for disposal.

This existing process ensures the proper management of medical waste from healthcare establishments to final disposal. It focuses on minimizing the environmental and health risks associated with medical waste while maximizing recycling and safe disposal practices.

Improved management system

- Waste Segregation: At the source of generation (healthcare facilities), waste is segregated into categories such as general waste, hazardous waste (e.g., sharps, cytotoxic drugs), and infectious waste (e.g., contaminated gloves, dressings).
- Proper Collection: Trained personnel collect segregated waste using color-coded bins and containers. Hazardous and infectious waste is clearly marked.
- Transportation: Waste is transported in dedicated, leak-proof, and secure vehicles to prevent spillage and contamination during transit.
- Waste Treatment: Different types of healthcare waste require specific treatment methods. Common treatments include:
  - **Incineration:** Hazardous and infectious waste is incinerated at high temperatures to reduce volume and eliminate pathogens.
  - **Autoclaving:** Some infectious waste is autoclaved (steam sterilized) before disposal.
  - Chemical Treatment: Certain chemical waste, like cytotoxic drugs, may require chemical treatment for safe disposal.
  - **Landfilling:** Non-hazardous, non-infectious waste is safely disposed of in designated landfills.
- Monitoring and Compliance: Regular monitoring ensures that waste management procedures comply with environmental and safety regulations.
- Education and Training: Continuous training and awareness programs are conducted for healthcare staff to promote proper waste handling.
- Documentation: Detailed records are maintained, including the quantity and type of waste generated, treatment methods used, and disposal processes.
- Environmentally Friendly Practices: Emphasis on eco-friendly waste management techniques, such as recycling or safe disposal of chemical waste.
- Community Engagement: Engaging with the local community to raise awareness about the importance of healthcare waste management and how to safely handle medical waste at home.
- Review and Improvement: Periodic reviews are conducted to assess the effectiveness of the waste management system and identify areas for improvement.
- Regulatory Compliance: Ensure compliance with national and international regulations related to healthcare waste management.
- Emergency Response: Develop protocols for handling accidental spills or other emergency situations to minimize risks.
- Public Reporting: Transparency in reporting waste management practices to the public, ensuring accountability.

Conclusion

In conclusion, this research paper sheds light on the current state of healthcare waste management in the city. It emphasizes the need for improved waste management practices to protect public health and the environment. The study proposes eco-friendly alternatives and highlights the importance of adopting sustainable waste disposal methods.

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