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Rural and Urban Biomedical Waste Management System in Murshidabad: A Comparative Study of Khargram Rural Hospital and Kandi Subdivision Hospital

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Abstract:
Efficient handling and management of biomedical waste generated in medical sectors is very important for safeguarding human health and the environment. Biomedical waste includes various infectious, hazardous and non-hazardous materials that can create significant problems if it is not disposed of properly.
This paper tries to describe biomedical waste management methods practised in rural and urban medical centres in Murshidabad, with a focus on Khargram Rural Hospital and Kandi Subdivision Hospital. The main objectives of this paper are to identify the gap between rural and urban waste management by examining the process to segregate, collect, transport and dispose of the medical waste and to identify the challenges and propose measures to manage these issues by making a healthy environment through the effective functioning of this system. 30 staff members have been selected from both hospitals to conduct the study. A telephonic interview was also conducted for better understanding of the management practices.
The findings identified a gap between rural and urban biomedical waste management practices in the study area. Both Khargram Rural Hospital and Kandi Subdivision Hospital are not that efficient in handling the medical waste. But the situation is worse in Khargram Rural Hospital. Regular training, adequate disposal infrastructures, adequate financial support and efficient communication of waste management regulation and guidelines are very necessary for better understanding and development of biomedical waste management procedures in Murshidabad.

Keywords: Biomedical waste, environmental health, hazardous waste, waste disposal, waste management practices

Introduction:

Biomedical waste management is gradually becoming a leading concern in recent centuries for its potential to cause serious health hazards and environmental pollution. In developing countries like India, with increasing population, the demand for medical services has increased. It has led to expansion in medical facilities. Greater use of medical products and medical technological advancement have multiplied the

generation of biomedical waste (Bansal, 2022)[1]. According to the World Health Organization, biomedical waste considers all types of waste produced in clinics, hospitals, research centres and laboratories at the time of medical activities. It also includes waste generated from minor sources such as medical care given at home in the form of home dialysis, insulin injection, recovery care, etc.

From a medical perspective, biomedical wastes are divided into two types: general healthcare waste or non-hazardous waste and hazardous waste. 75%-90% of medical waste is non-hazardous waste; that includes paper waste, food waste, non-contaminated equipment, etc. The remaining 10%-25% of medical waste is regarded as hazardous waste that includes infectious waste, sharps, pathological, chemical, radioactive and pharmaceutical waste. Although a major portion of medical waste is non-hazardous, it can be hazardous if it is not treated properly. Improper biomedical waste management can create significant environmental problems (Dey et al., 2023)[2]. In comparison to urban areas in this country, rural areas face more difficulties in this waste management procedure due to lack of instruments, lack of technology, and limited resource availability. In the year 2022-23, the total amount of biomedical waste generation in India is 764 tonnes per day, and 721 tonnes per day is disposed of by the process of Common Bio-medical Waste Treatment Facilities (CBWTFs) and captive treatment facilities (CPCB, 2024)[3]. West Bengal has 9187 biomedical healthcare units, and the waste generated from these units is 41456.96 kg/day. Incineration and autoclaving are two main treatment facilities followed here. Total waste disposed of by the incineration process is 25943.41 kg/day and by autoclaving is 15513.55 kg/day, i.e., 41456.96 kg/day. Murshidabad district, having 492 healthcare units, generates 1704.77 kg/day of waste. Waste disposed of by the incineration method and autoclaving method is 1290.89 kg/day and 413.88 kg/day, respectively (WBPCB, 2024)[4].

Review of literature:

Akter (2000), in his research 'Medical waste management: a review', reports that medical waste management systems worldwide generally have unsafe disposal practices such as burning, burying, and dumping, and most medical wastes (externally clinical) usually include both clinical and non-clinical types mixed together. Hospital staff and waste handlers lack awareness of safe disposal methods, which results in the risk of contaminating environments with medical waste. There is a high potential for health and environmental hazards from medical waste to humans and animals. The research calls for more awareness of proper medical waste management practices and more studies of medical waste disposal techniques and technology in developing countries[5].

Ali et al. (2017) in their study 'Hospital waste management in developing countries: A mini review' have identified how a number of different types of hospital-generated hazardous waste from healthcare activity in developing countries pose serious risks to the environment and public health due to a lack of safe disposal methods that are hindered by limited financial resources and inconsistent definitions and measurement of levels of different types of hospital waste and methods that vary widely from facility to facility. The poor management of waste segregation from source, collection and disposal practices is another contributing factor to the accumulation of significant occupational and environmental hazards associated with hospital waste as a result of low awareness and inadequate training for hospital staff combined with limited means to wear adequate protective equipment. The illegal recycling of unsegregated hospital waste is a further risk in an already hazardous situation. The use of sustainable hospital waste management practices can help eliminate many of the environmental and public health risks created by unregulated or poorly managed hospital waste[6].

Das and Biswas (2016), in their study 'Awareness and Practice of Biomedical Waste Management among Healthcare Providers in a Tertiary Care Hospital of West Bengal, India', stated that biomedical waste (BMW) is produced while carrying out a procedure or conducting research related to human health and is detrimental to both people's and the planet's health. Thus, effective management of BMW will be a legal and social responsibility of the healthcare industry. It is with this intent this study was conducted at a tertiary care hospital to find out healthcare providers' level of awareness and practices regarding BMW management. Of the 198 individuals in this study, the majority were young adults (60.6% were 21-30 years old), and only 1.5% had undergone formalised training regarding BMW management. Although all participants were aware of the existence of BMW management, only 6.6% recognised the proper colour codes for the segregation of BMW, and only 31.3% recognised the proper methods of disposal of sharps. The majority of participants wore personal protective equipment; however, 33.3% of the observations indicated the reuse of syringes. The findings suggest that there are major gaps between knowledge and practice related to BMW management and underscore the importance of ongoing education/training and strict compliance with BMW management protocols[7].

Dey et al. (2023), in their study 'Assessment of infrastructure and status of biomedical waste management in primary health-care facilities in a district of West Bengal, India', have identified major problems with the management of Biomedical Waste (BMW) in various Primary Health Care Facilities in Murshidabad District, West Bengal. Issues noted included poor infrastructure, lack of awareness of BMWM, insufficient resources available for the collection and disposal of BMW, and inadequate BMW disposal methods. The authors wanted to evaluate the current BMWM infrastructure and determine what was missing concerning the current method of managing BMW. The authors presented several recommendations to improve the current practice of BMWM. One recommendation was to improve logistics and supply chain management (SCM). Other suggestions made were to fill the vacant Group D staff positions and improve the training and monitoring of healthcare providers[2].

Khan et al. (2019), in their journal 'Healthcare waste management in Asian developing countries: A mini review' found that healthcare waste management in many developing nations in Asia is plagued by a variety of challenges, including inadequate resources and systems for waste segregation, collection, storage and disposal. Despite there being regulations, they differ greatly from one nation to another, thus contributing to an inconsistent and unreliable means for measuring waste. Improperly trained personnel contribute to improper handling and pose a health threat to individuals and communities. Unsafe practices for recycling and confusion regarding the differences between the use of a landfill and open dumping are further compounding the environmental impact. Many of the incinerators used today need to be replaced with safer alternatives like autoclaves and pyrolysis. Enhancements in waste management will greatly improve the ability to provide healthy environments for humans and protect environmental health[8].

Pal et al. (2019), in their study 'Assessment of knowledge and practices of biomedical waste management and infection control among health assistants in a rural block of Nadia district, West Bengal', indicated that the potential to create serious health and safety/environmental consequences resulted from improper disposal of biomedical waste and a lack of precautionary measures taken by healthcare personnel. The researchers assessed the waste management patterns and shared responsibility for infection control of healthcare aides from 40 sub-centres within the Chakdaha Block, located in the Nadia District, West Bengal. The results indicated that over 60% of the sampled healthcare aides had low levels of waste management and infection control knowledge and practice and no significant correlation between what they knew about proper waste management or infection control and the way they acted to prevent

infections or dispose of waste. The research team concluded that in order to improve these two areas, both pre-service training should be provided and onsite supervision by management is critical in enhancing the healthcare aides' understanding of correct waste management and infection control[9].

Rao (2008), in his report 'Hospital waste management — awareness and practices: a study of three states in India', which included findings from three states in India, assessed awareness and practices related to biomedical waste management in urban vs rural hospitals, nursing homes and private practitioners. The study identified deficiencies in segregation (i.e., sorting according to type), colour coding (i.e., using specific colours for different types of waste), and management of sharps. Points of waste management and disposal. For example, although 70% of the facilities used needle cutters, only 35% had access to common waste management services. Waste dumping outside of hospitals is a regular practice, and there were also concerns regarding lack of sufficient oversight and monitoring of these practices. These findings underscore the need for stronger compliance enforcement materials/protocols to protect the health of the general public[10].

Wadhwani (2006) in her thesis 'Hospital Waste Management in Calcutta Metropolis – An Appraisal' noted that hospital waste management is greatly neglected as a result of increased healthcare facilities and consequently more antibiotic use, cytotoxic drugs, chemicals and radioactive materials; in addition, there are more infections such as HBV and HIV. As a result, improper waste disposal methods are often employed when hospital waste is discharged via sewage and/or discharged into the sewer, therefore creating a pressing need for effective waste management techniques. The study on waste management practices at Safdarjung Hospital in New Delhi and N.R.S. Hospital in Kolkata indicates that none of the key components of waste management, including storage, segregation, transportation, or treatment, are implemented properly. The methods of disposal of waste, including incineration, chemical disinfection, and landfilling, were not compliant with the Ministry of Environment and Forest (M.O.E.F.) guidelines. Lastly, it has been indicated that methods of sterilization such as autoclaving and microwave technology may be better options for hazardous hospital waste management[11].

Windfeld and Brooks (2015) in their paper 'Medical waste management – A review' examines the management of medical waste, including the various sources, legal frameworks and disposal methods. While most developed nations have existing regulations regarding the management of medical waste, many times there are ambiguities concerning the definition of "infectious" and what items fall under this category. These ambiguities lead to an increase in the amount of waste being treated as 'infectious', through the utilization of incinerators, resulting in higher disposal costs and detrimental impacts on the environment. The authors stress the importance of more effective education on medical waste management for healthcare practitioners and the implementation of national standards for the sorting of medical waste to improve the efficiency of medical waste management. The authors also call for additional studies on the increased production of medical waste in conjunction with the rise of global gross domestic product (GDP)[12].

Objectives:

Main objectives of the study are:

- To know about current waste management process followed in Khargram Rural Hospital and Kandi Subdivision Hospital and compare the differences in rural-urban waste management practices.
- To identify challenges in biomedical waste management and to provide recommendations for improving waste management systems, with a focus on enhancing safety, efficiency, and compliance

in Khargram Rural Hospital and Kandi Subdivision Hospital.

Database and Methodology:

The study is based on both primary and secondary data. Primary data has been collected with the help of a survey schedule from two selected hospitals of the Kandi subdivision. Total 60 healthcare professionals, 30 members from Khargram Rural Hospital and 30 members from Kandi Sub-division Hospital were selected through random sampling. Apart from this, telephonic interview was conducted with a staff member of Enviro-solution Agency to gain deeper knowledge about the waste management procedure. Necessary secondary data have been collected from various e-journals, e-books, reports published by government and environmental boards, websites, etc.

Study Area:

Murshidabad district, a famous district in West Bengal lies between 23º43′ North to 24º52′ North latitude and 87º49′ East to 88º44′ East longitude and bounded by Bangladesh in the East, Jharkhand state and Birbhum district in the west, Maldah district in the North and Nadia and Barddhaman district in the South. It has acquired 5324 sq. km of geographical area with its five subdivisions, namely Berhampore-Sadar, Jangipur, Kandi, Domkal and Lalbag (District Census Handbook: Murshidabad District; 2011)[13]. There is 1medical college and hospital, 3 super-speciality hospitals, 4 sub-division hospitals, 1 mental hospital, 18 rural hospitals, 9 block primary health centres, 81 primary health centres and 832 sub-centres (Office of The District Magistrate, Murshidabad, 2025)[14]. To conduct the study, one rural hospital (Khargram Rural Hospital) and one municipality hospital (Kandi Subdivision Hospital) have been taken.

Khargram Rural Hospital is a 60 bedded hospital located in 24° 2' North latitude and 87° 59' East longitude at Khargram C.D. Block, Murshidabad. It provides healthcare services to rural villagers in the surrounding areas.

Kandi Subdivision Hospital is an important hospital in this district located in 23° 57' North latitude and 88° 1' East longitude in Kandi municipality under Kandi C.D. Block, Murshidabad. It is a 100 bedded hospital that provides healthcare service to all the rural hospitals under this hospital and the local residents.

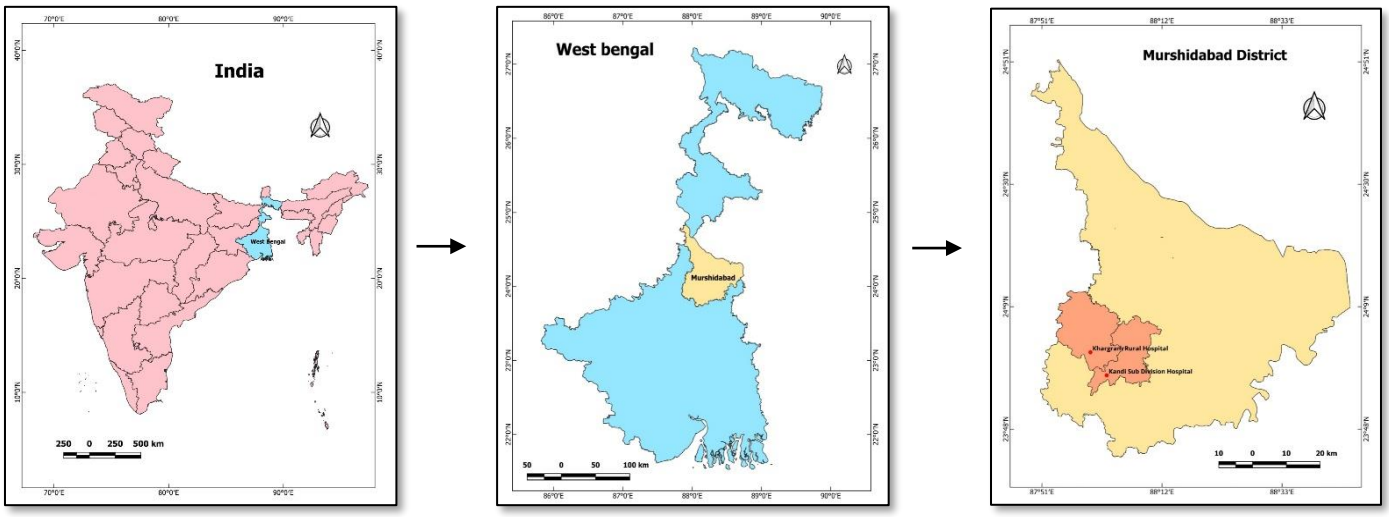


Figure 1: Location Map of the Study Area

Source: https://onlinemaps.surveyofindia.gov.in/ ; Software used: QGIS-3.22 (Open Source); Prepared by Authors.

Results and Discussion:

The biomedical waste management procedure is mainly controlled and managed by pollution control boards of different states of this country. The Biomedical Waste Management Rules 2016 segregate the biomedical waste generated from medical centres into 4 categories, based on colour code. Then it is collected, transported, stored and finally disposed of (Biomedical Waste Management Rules, 2016)[15].

Figure 2: Different Types of Biomedical Waste

Source: https://www.collidu.com/presentation-bio-medical-waste-management

Primary survey has been conducted to know about the present condition of biomedical waste management practices that prevail in Khargram Rural Hospital and Kandi Sub-division Hospital and find the gap in rural-urban waste management practices. Data reveals that there are few differences in these practices mentioned below:

Table 1: Differences in the Demographics of the Respondents

Aspect	Khargram Rural Hospital	Sample	Kandi Sub Division Hospital	Sample
Gender Distribution	Male	60%	Male	17%
	Female	40%	Female	83%
Age Distribution	20-30 years	50%	20-30 years	77%
	30-40 years	33%	30-40 years	13%
	40-50 years	7%	40-50 years	10%
	50-60 years	10%	50-60 years	0%
Position of Respondents	Doctor	13%	Doctor	3%
	Nurse	13%	Nurse	77%
	Technician	7%	Technician	3%
	Administrative	34%	Administrative	7%
	Other Staff	33%	Other Staff	10%

Experience of Respondents	0-10 years	67%	0-10 years	80%
	10-20 years	23%	10-20 years	10%
	20-30 years	7%	20-30 years	10%
	<30 years	3%	<30 years	0%

Source: Primary Survey, September, 2025.

Awareness and knowledge: Study reveals that in Khargram Rural Hospital, 83% of respondents are aware of different categories of biomedical waste management procedures, and 17% of respondents still lack knowledge (Figure 3); while in Kandi Subdivision Hospital, 93% of respondents are aware of these management procedures, but 7% of respondents are not aware of them (Figure 4). A colour-coding system is an important method for waste segregation and disposal. In Khargram, 80% of respondents are familiar about this colour coding system. It shows a gap in in this process that can lead to improper disposal. But in Kandi, 100% of respondents are familiar about this colour coding system indicating a high abidance of waste management guidelines here (Figure 5).

Figure 3: Awareness of Respondent about different categories of biomedical waste in Khargram Rural Hospital

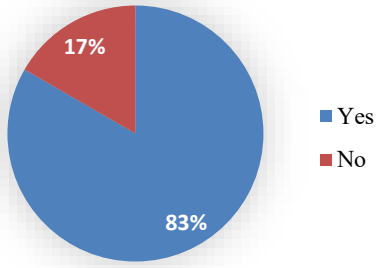


Figure 4: Awareness of Respondent about different categories of biomedical waste in Kandi Subdivision Hospital

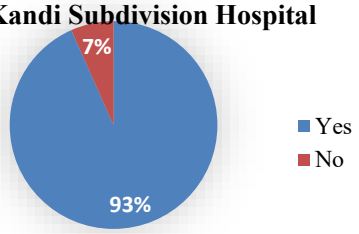
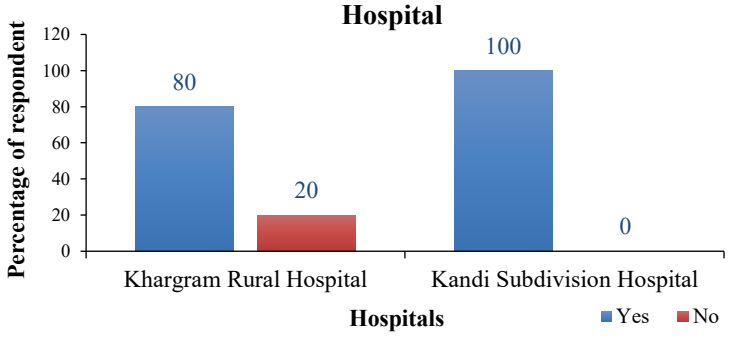


Figure 5: Knowledge of respondent about colour-coding system used for segregating biomedical waste in Khargram Rural Hospital and Kandi Sub-divisional Hospital



Attitudes Towards Waste Management:

Likert Scale analysis given by Rensis Likert (1932) has been used to analyse the following information given by the respondents:

Table 2: Attitudes Towards Waste Management

Opinion Scale	Likert Scale Value	
	Khargram Rural Hospital*	Kandi Subdivision Hospital*
Proper hospital waste management is very important for public health	4.8 (Strongly Agree)	5 (Strongly Agree)
You are very knowledgeable about biomedical waste management	3.83 (Agree)	4.3 (Strongly Agree)
Proper segregation of biomedical is essential for patient safety	4.93 (Strongly Agree)	5 (Strongly Agree)
Current waste management practices in your hospital are very effective	3.87 (Agree)	4.5 (Strongly Agree)

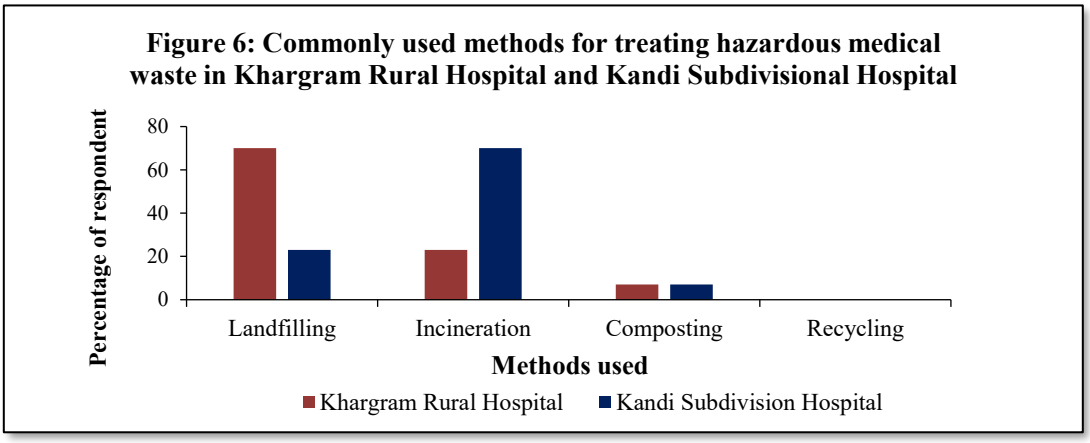
Source: Primary Survey, September, 2025. *Calculated by authors

5-point Likert scale is used here that shows 4.21-5.00 – strongly agree, 3.41-4.20 – agree, 2.61-3.40 – neutral, 1.81-2.60 – disagree, and 1.00-1.80 – strongly disagree. From the following analysis, it is evident that the respondents from both the hospitals show positive attitudes towards the biomedical waste management process. But Kandi Subdivision Hospital demonstrates higher consistency and satisfaction regarding the waste management practices than Khargram Rural Hospital.

Waste Management Practices:

97% of respondents in Khargram reported that waste segregation is practised here regularly, while 100% of respondents in Kandi confirmed that the segregation process is followed regularly here. Figure 6 highlights different methods used for treating the hazardous waste in these areas. At Khargram Rural Hospital, 70% of respondents reported that landfilling is the primary method used for biomedical waste management. It indicates the dependence on lower costs, access to landfill sites and unavailability of advanced methods. 23% of respondents reported incineration as the second most used method, while only 7% reported composting as another method used for this purpose. On the other hand, in Kandi Subdivision Hospital, 70% of respondents reported incineration as the most used hazardous waste management method. 23% reported landfilling as the second most used method, which indicates that Kandi Subdivision Hospital made a step towards advanced treatment processes for environmental sustainability. Only 7% reported composting as another waste management method.

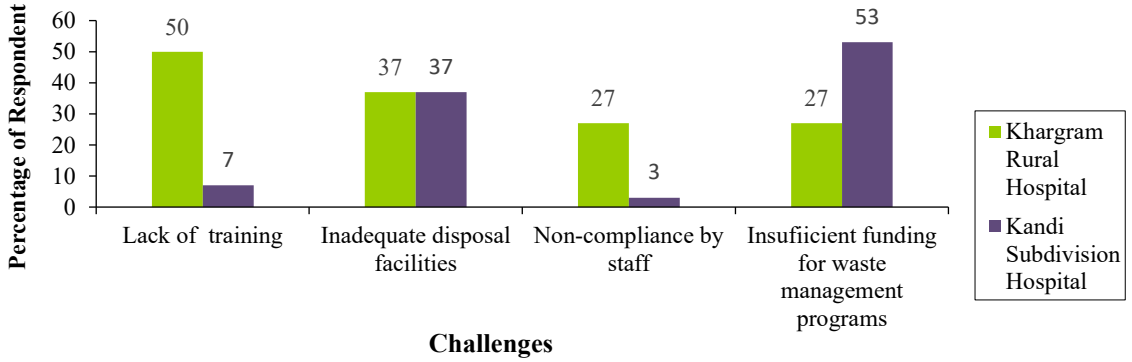
Figure 6: Commonly used methods for treating hazardous medical waste in Khargram Rural Hospital and Kandi Subdivisional Hospital



Challenges:

The primary survey identified four major issues as big challenges in both hospitals. In Khargram Rural Hospital, lack of training (50%) has been identified as the biggest problem. Inadequate disposal facilities (37%), insufficient funding for waste management programmes (27%), and non-compliance by staff (27%) are other challenges faced by the hospital authorities. In Kandi Subdivision Hospital, insufficient funding for the waste management programme (53%) is identified as the biggest challenge. Inadequate disposal facilities (37%), lack of training (7%) and non-compliance by staff (3%) are other major issues faced by them (Figure 7).

Figure 7: Challenges Faced by Respondents in Waste Management in Hospitals



Recommendation:

To address these challenges, a few recommendations are given to strengthen the biomedical waste management practices in this area:

- Regular training programmes should be conducted for healthcare professionals, staff and waste handlers. It will encourage them to gain better knowledge about waste segregation, transport, storage and disposal.
- Biomedical waste disposal infrastructures, including proper storage areas, proper landfills, and well-organised incinerators, should be improved.
- Adequate financial support is also very necessary for the smooth functioning of waste management practices. It will also help to hire skilled professionals, initiate waste management programmes and proper monitoring.
- Efficient communication of waste management regulations and guidelines is also necessary for the stakeholders for better understanding about their responsibilities.

Conclusion:

In conclusion, it can be said that both Khargram Rural Hospital and Kandi Subdivisional Hospital face various challenges regarding biomedical waste management procedures. In spite of these challenges, these hospitals continuously provide healthcare services to local people of surrounding areas. It is clear that Khargram Rural Hospital has fewer opportunities to develop the waste management practices in comparison to Kandi Subdivision Hospital. Joint efforts of hospital authorities, staff, other members, non-government organisations, and local communities are needed to reduce this rural-urban biomedical waste management gap, deliver a more secure healthcare system, and make a sustainable medical environment.

References:

1. Bansal, K. (2022). Hospital Waste Management and Environment Problems in India. Journal of Pharmaceutical Negative Results, 13 (7), 3390-3396. DOI: 10.47750/pnr.2022.13. S07.438
2. Dey, S., Ghosh, R. & Mallik, S. (2023). Assessment of infrastructure and status of biomedical waste management in primary health-care facilities in a district of West Bengal, India: A mixed method study. MRIMS Journal of Health Science, 11, 190-195. DOI: 10.4103/mjhs.mjhs_63_22. Available on: https://journals.lww.com/mjhs/fulltext/2023/11030/assessment_of_infrastructure_and_status_of.4.aspx
3. Central Pollution Control Board. (2024). Annual report 2022–23. Ministry of Environment, Forest and Climate Change, Government of India. https://cpcb.nic.in
4. West Bengal Pollution Control Board. (2024). Annual report 2024. Department of Environment, Government of West Bengal. https://www.wbpcb.gov.in
5. Akter, N. (2000). Medical waste management: a review. Research Reports (1999): Health Studies, Vol - XXVIII, 370–394. Available on: https://dspace.bracu.ac.bd/xmlui/handle/10361/12964
6. Ali, M., Wang, W., Chaudhry, N. & Geng, Y. (2017). Hospital waste management in developing countries: A mini review. Waste Management & Research: The Journal for a Sustainable Circular Economy, 35 (6), 581-592. doi:10.1177/0734242X17691344.Available on: https://journals.sagepub.com/doi/abs/10.1177/0734242X17691344
7. Das, S. K., & Biswas, R. (2016). Awareness and practice of biomedical waste management among healthcare providers in a Tertiary Care Hospital of West Bengal, India. International Journal of Medicine and Public Health, 6, 19-25. DOI: 10.4103/2230-8598.179755. Available on: https://www.ijmedph.org/Uploads/Volume6Issue1/IntJMedPubHealth-6-1-1-19.pdf
8. Khan, B.A., Cheng, L., Khan, A. A. & Ahmed, H. (2019). Healthcare waste management in Asian developing countries: A mini review. Waste Management & Research, Vol. 37(9) 863–875. DOI: 10.1177/0734242X19857470. Available on: https://journals.sagepub.com/doi/full/10.1177/0734242X19857470
9. Pal, J., Biswas, M., Nandi, S. & Biswas, A. K. (2019). Assessment of knowledge and practices of biomedical waste management and infection control among health assistants in a rural block of Nadia district, West Bengal. International Journal of Community Medicine and Public Health, 6(10), 4462-4469. DOI: http://dx.doi.org/10.18203/2394-6040.ijcmph20194513.
10. Rao, P.H. (2008). Hospital waste management - awareness and practices: a study of three states in India. Waste Management & Research: The Journal for a Sustainable Circular Economy, 26(3), 297-303. doi:10.1177/0734242X08088693. Available on: https://journals.sagepub.com/doi/abs/10.1177/0734242x08088693
11. Wadhwani, S. (2006). Hospital waste management in Calcutta metropolis - an appraisal. Doctoral Thesis, University of Calcutta. Available on: http://hdl.handle.net/10603/155994
12. Windfeld, E.S., & Brooks, M. S. (2015). Medical waste management – A review. Journal of Environmental Management, 163, 98-108. Available on: https://www.sciencedirect.com/science/article/abs/pii/S0301479715302176
13. Directorate of Census Operations, West Bengal. (2011). District census handbook: Murshidabad district—Village and town wise primary census abstract,2011. Office of the Registrar General & Census Commissioner, India.

14. Office of The District Magistrate, Murshidabad, (December, 2025). Government of West Bengal. https://murshidabad.gov.in/health/
15. Biomedical Waste Management Rules (2016). Guidelines for management of healthcare waste. Ministry of Environment, Forest and Climate Change, Government of India, 5-23.