Healthcare Waste Management Practices in Selected Healthcare Institutions within Kailali District of Nepal

Prakriti Paudel P[1], Arjun Aryal[2], Yadav Prasad Joshi[3], Basant Thapa[4], Janak Thapa[5], Yamuna Marasini[5], Shiv Kumar Shah[6], Bhim Timilsina[7]

[1]Department of Environmental and Occupational Health, Faculty of Science, Health and Technology, Nepal Open University, Nepal
[2]Central Department of Public Health (CDPH), Institute of Medicine, Tribhuvan University, Kathmandu, Nepal
[3]Department of Public Health, Manmohan Memorial Institute of Health Sciences (MMIHS), Kathmandu, Nepal
[4]FHI 360, Kathmandu, Nepal
[5]Department of Public Health, Faculty of Medical and Allied Health Science, Purbanchal University, Nepal
[6]Department of Pharmacy, Faculty of Medical and Allied Health Science, Purbanchal University, Nepal
[7]Department of Civil Engineering, Institute of Engineering, Tribhuvan University, Nepal
Corresponding Author: Arjun Aryal, email: drarjunaryal@gmail.com, ORCiD: 0000-0002-0934-6097

Abstract

Background and Objectives: *Proper healthcare waste management (HCWM) is crucial for preventing public health risks and environmental contamination. While HCWM has received more focus in recent years, developing countries like Nepal still face challenges in its implementation. This study aimed to evaluate HCWM practices in the healthcare institutions in the Kailali district of Nepal, including both hospitals and health posts.*

Materials and Methods: *A cross-sectional study design was employed to provide a comprehensive understanding of HCWM practices. Semi-structured interviews were implemented to gather data from individuals responsible for HCWM in each of the selected healthcare facilities (HFs), supplemented by on-site observations. Ethical clearance was obtained from Nepal Health Research Council and ethical standards were followed.*

Results: *The amount of waste generated by the HFs ranged from 1 kg to over 50 kg daily with an average of 10 kg per day. The majority of the facilities (80%) segregated waste at the point of generation, and labelling was used in segregation containers in 80% of the facilities. Most facilities (80%) used plastic bins for waste collection, and the frequency of waste collection varied, with 30% of facilities collecting waste three times a day, 30% collecting according to waste quantity, 30% collecting once a day, and 10% collecting twice a day. All facilities had good lighting, ventilation, drainage, water supply, and needle-proof containers in their waste storage areas. The duration of waste storage varied, with 40% of facilities storing waste for six hours, 20% for 72 hours, 20% for 168 hours, 10% for 12 hours, and 10% for 96 hours. Nine out of the ten facilities (90%) practiced some form of waste treatment before disposal. The most common methods were chemical disinfection (70%), burial (60%), and burning (50%).*

Conclusion: *This study revealed significant variations in HCWM practices across the different healthcare facilities in Nepal, highlighting the need for context-specific strategies. The findings underscore the importance of standardized HCWM protocols tailored to individual health facility needs, comprehensive staff training, and investment in adequate infrastructure and availability of resources to ensure safe and effective HCWM. By addressing these key areas, healthcare facilities in Nepal and similar settings can minimize public health risks and environmental pollution.*

Keywords: *healthcare waste management, healthcare facilities, waste segregation, waste disposal, Nepal*

Introduction

Healthcare waste (HCW) involves all of the waste materials generated by healthcare facilities, research centers and laboratories (Janik-Karpinska et al., 2023; Neves et al., 2022a). While the majority (80%-85%) of this waste is non-hazardous, and the remaining 15% to 20% stances significant risks due to its infectious, toxic, or radioactive nature.(Aziz et al., 2022; Bolan et al., 2023) These hazardous materials can originate from various sources within the healthcare sector, including hospitals, laboratories, mortuaries, blood banks, and nursing homes (Zikhathile et al., 2022). Effective healthcare waste management (HCWM) is therefore critical, encompassing all processes from waste generation and segregation, as well as transportation, storage, treatment, and final disposal (Bolan et al., 2023; Dzakuma, 2022; Tiruneh et al., 2024). Each stage demands meticulous attention to ensure the safety of healthcare workers, the surrounding environment, and public health (Aziz et al., 2022; Nabavi-Pelesaraei et al., 2022).

The hazardous nature of HCW stems from several factors, including the presence of contagious agents, genotoxic or cytotoxic chemicals, poisonous pharmaceuticals, radioactive substances, and sharps (Dzakuma, 2022; Marfe & Stefano, 2020). Improper handling and disposal of such waste can lead to severe health consequences and environmental pollution (Li & Achal, 2020; Shetty et al., 2023). Globally, healthcare waste is considered a major hazardous waste category. (Shetty et al., 2023) Studies have linked inadequate HCWM to increased risks of infections, particularly among waste handlers and communities residing near disposal sites (Abubakar et al., 2022; Dzakuma, 2022). These infections can range from gastrointestinal parasites to more serious diseases like cholera, yellow fever, and hepatitis B and C (Addy et al., 2023; Selvan Christyraj et al., 2021). Alarmingly, recent data estimated that approximately 1.2 million deaths annually are attributed to waste-related diseases in low-income and middle-income countries (Anokye et al., 2024; Nalwanga et al., 2023). Despite the gravity of these risks, HCWM has historically been a low priority in developing countries like Nepal (Haque et al., 2022; S. Sapkota et al., 2020). However, recent years have witnessed a growing recognition of the importance of proper HCWM practices (Gautam et al., n.d.; Udayanga et al., 2023). Several studies conducted in Nepal have highlighted persistent challenges in HCWM, including the absence of facility-level policies, inadequate infrastructure, insufficient training, and a lack of awareness among healthcare workers (Pathak et al., 2021; Pradhananga et al., 2021; Shrestha et al., 2022). While some larger hospitals may possess incinerators, these often lack pollution control mechanisms, posing further environmental and health hazards (B. Sapkota, 2022).

This study aims to assess HCWM practices in Kailali district of Nepal, encompassing both hospitals and health posts. This study aims to assess existing practices and pinpoint areas that require enhancement, ultimately contributing to the advancement of more effective and sustainable HCWM strategies in Nepal.

Methods and Materials

Study Method and Design

This study utilized a cross-sectional design to provide a comprehensive understanding of healthcare waste management (HCWM) practices in the Kailali district of Nepal. This approach involved the collection of numerical data from a representative sample of healthcare facilities at a specific point in time. The data was collected through standardized questionnaires and on-site observations, focusing on quantifiable aspects of HCWM practices such as the number of outpatients and inpatients per day, the total number of beds, the amount of waste generated per day, the types of waste generated, the methods used for waste segregation, collection, storage, treatment, and final disposal.

Study Site and Sample

The Kailali district was purposively selected for this study due to its diverse range of healthcare facilities, including both hospitals and health posts, representing a variety of HCWM challenges and practices. This selection allowed for a comprehensive assessment of HCWM practices across different levels of healthcare delivery in a region facing resource constraints and infrastructural limitations. The study was conducted in purposively selected healthcare facilities across various locations within the Kailali district. A purposive sampling method was used to select the ten participating healthcare facilities, ensuring the inclusion of both hospitals and health posts to capture a range of HCWM practices and challenges.

Data Collection

Semi-structured interviews were implemented to gather data from individuals responsible for HCWM in each of the ten selected HFs. A standardized questionnaire was developed to guide the interviews, ensuring consistency in data collection. In addition to interviews, on-site observations were conducted to augment the interview data and offer a more thorough comprehension of the actual practices of HCWM.

Data Analysis

The quantitative data was entered into SPSS version 26 for statistical analysis. The data was summarized using descriptive statistics, which included frequencies and percentages to identify patterns, trends, and associations related to HCWM practices in the selected healthcare facilities.

Validity and Reliability

To ensure the validity and reliability of the study, a pre-test of the questionnaire was conducted, and necessary modifications were made based on the feedback received. Consultations were held with subject matter experts, and co-authors throughout the research process to maintain rigor and address any potential biases. Data were consolidated efficiently following collection, and analytical methods were utilized for ensuring precision and impartiality in the study.

Ethical Considerations

The Ethical Review Board (ERB) of the Nepal Health Research Council (NHRC) granted ethical sanction to the investigation. Prior to data collection, all participants were granted informed assent. The study was conducted with the utmost confidentiality, and the results were used solely for research purposes. For confidentiality reasons, the names of the hospitals and health posts have not been mentioned in the article. Participants were informed that they could disengage from the study at any time without incurring any consequences.

Results

This section presents the findings of the study, starting with a description of the participating healthcare facilities and followed by an analysis of the different aspects of healthcare waste management (HCWM) practices observed in these facilities.

Table 1: General characteristics of healthcare institutions

Indicator	Hospital	Health Post	All Health Facilities
No. of outpatients/day	9-105	25-60	9-105
No. of inpatients/day	2-25	N/A	2-25
Total no. of bed	7-50	1-4	1-50

Note: N/A=Not Applicable

Table 1 presents the general characteristics of the participating healthcare facilities, including the number of outpatients and inpatients per day and the total number of beds. In general, hospitals exhibit a broader range of indicators across all three categories: the daily number of outpatients, inpatients, and the total number of beds. This

difference is amplified when comparing hospitals to health posts, but the overall range for all health facilities remains quite wide. For instance, the number of outpatients per day in hospitals ranged from 9 to 105, while in health posts, the range was considerably narrower, from 25 to 60. This results in a range of 9 to 105 outpatients per day across all health facilities.

Furthermore, hospitals accommodate inpatients, with a daily range of 2 to 25, while health posts do not have this capacity. Therefore, the range of inpatients per day for all health facilities remains 2 to 25. The total number of beds in hospitals also exhibited greater variation, ranging from 7 to 50, compared to a range of 1 to 4 in health posts. Across all facilities, the total number of beds ranges from 1 to 50, demonstrating the variability in capacity across the healthcare system.

Table 2 Total waste generation per day.

Estimated amount of waste	Frequency	Percentage (%)
1kg	4	40
5 kg	3	30
10kg	2	20
50kg	1	10

The table 2 reveals that the majority of the healthcare facilities (40%) generated about 1 kg of waste per day, indicating relatively low levels of waste production in these settings. Thirty percent of the facilities generated up to 5 kg of waste per day, suggesting moderate levels of waste production. Twenty percent generated approximately 10 kg of waste daily, indicating higher waste production volumes. However, it is crucial to note that Hospital "B" generated over 50 kg of waste per day, highlighting the substantial waste generation.

Table 3. Colour of buckets or bags or places for different types of waste segregation

Type of Waste (n=10)	Frequency	Percentage (%)
General Waste		
Dig	1	10
Blue	1	10
Green	7	70
Red	1	10
Sharps		
Blue	1	10
Red	1	10
Tin box	1	10
Safety box	7	70
Hazardous Waste		
Dig	1	10
Blue	4	40
Red	4	40
Placenta pit	1	10
Pharmaceutical Waste		
Dig	1	10
Blue	5	50
Green	1	10
Red	1	10
Separate blue	1	10
Liquid Waste		
Dig	1	10
Blue	1	10
Red	3	30
Placenta pit	4	40
Recyclable Waste		
Dig	1	10
Blue	3	30
Green	3	30
Separate blue	1	10

Note: The frequencies of some features sum up to less than ten due to 'other' responses.

Table 3 presents the color-coded buckets/bags or designated places used for segregating different types of healthcare waste (HCW) in the participating healthcare facilities. Green buckets were the most common method for segregating general waste (70%), while safety boxes were most frequently used for sharps (70%). For hazardous waste, blue

and red buckets were used with equal frequency (40% each). Blue buckets were the most common for pharmaceutical waste (50%), and placenta pits were most frequently used for liquid waste (40%). For recyclable waste, blue and green buckets were used with similar frequency (30% each).

Table 4. Location of waste segregation and use of labeling in segregation containers

Waste Segregation Practices	Frequency	Percentage (%)
Location of waste segregation (Multiple Responses) (n=10)		
Respective department	3	30
Disposal Point	1	10
At waste generation	8	80
Labelling in segregation containers (n=10)		
Labeled	8	80

Table 4 presents the locations where waste segregation occurs and the use of labelling in segregation containers in the participating healthcare facilities. Based on the multiple responses, most facilities (80%) segregated waste at the point of generation, while 30% segregated waste in respective departments. Only one hospital segregated waste at all three locations: point of generation, respective departments, and disposal point. Labelling was used in segregation containers in 80% of the facilities.

Table 5. Waste collection practices in the healthcare facilities

Waste Collection Practices	Frequency	Percentage (%)
Provision of waste collection		
Plastic bins	8	80
Plastic and metal bins	2	20
Waste collection container covered		
Covered	9	90
Waste collection frequency		
According to waste quantity	3	30
3 times	3	30
2 times	1	10
1 time	3	30
Waste transportation		
Humans	10	100

Table 5 provides a summary of waste collection practices in the participating healthcare facilities. Most facilities (80%) used plastic bins for waste collection, while 20% used both plastic and metal bins. The majority (90%) used covered waste collection containers. The frequency of waste collection varied, with 30% of facilities collecting waste three times a day, 30% collecting according to waste quantity, 30% collecting once a day, and 10% collecting twice a day. All facilities used human resources for waste transportation.

Table 6. Waste storage practices of the healthcare facilities

Waste Storage Practices	Frequency	Percentage (%)
Waste storage system		
Impermeable floor	3	30
Easy to clean surface	5	50
Good lighting and ventilation	10	100
Good drainage	10	100
Convenient water supply	10	100
Secured and lockable	1	10
Pest-proof	1	10
Sharp-proof	10	100
Duration of waste storage (hours)		
6	4	40
168	2	20
72	2	20
96	1	10
12	1	10

Table 6 summarizes the waste storage practices of the participating healthcare facilities. All facilities had good lighting, ventilation, drainage, water supply, and needle-proof containers in their waste

storage areas. Fifty percent had easy-to-clean surfaces readily accessible to staff, while 30% had impermeable floors. Only one health post had a secured, lockable and pest-proof storage area. The duration of waste storage varied, with 40% of facilities storing waste for six hours, 20% for 72 hours, 20% for 168 hours, 10% for 12 hours, and 10% for 96 hours.

Table 7. Waste treatment methods employed by the healthcare facilities before final disposal

Waste Treatment Practices	Frequency	Percentage (%)
Waste treatment before disposal		
Practiced	9	90
Waste treatment method		
Chemical	7	70
Burial	6	60
Burning	5	50
Autoclaving, sterilization	4	40
Sanitary landfill	1	10

Table 7 shows the waste treatment methods employed by the participating healthcare facilities before final disposal. Nine out of the ten facilities (90%) practiced some form of waste treatment before disposal. The most common methods were chemical disinfection (70%), burial (60%), and burning (50%). Autoclaving or sterilization was used by 40% of the facilities, while only 10% used a sanitary landfill.

Table 8. Final disposal methods for different categories of healthcare waste

Waste Category	Final Disposal Method	Frequency	Percentage (%)
General waste			
	Burial	7	70
	Municipality land	2	20
	Matribhumi Samaj Sewa	1	10
Hazardous waste			
	Burial	3	30
	Placenta pit	3	30
	Municipality landfill	2	20
	Burning	1	10
Sharp waste			
	Burial	5	50
	Needle breaker	2	20
	Municipality	2	20
	Matribhumi Samaj Sewa	1	10
Liquid waste			
	Placenta pit	8	80
	Burial	1	10
Radioactive waste			
	Burial	2	20
	Burning	2	20
	Municipality	2	20
	Matribhumi Samaj Sewa	1	10
Pharmaceutical waste			
	Burial	2	20
	Municipality	2	20
	Burning	4	40
	Matribhumi Samaj Sewa	1	10
Final disposal of segregated waste (MR)			
	Buried on health institution ground	7	70
	Openly burned	6	60
	Municipality	2	20
	Matribhumi Samaj Sewa	1	10

Note: The frequencies of some features sum up to less than ten due to 'other' responses.

Table 8 presents the methods used for the final disposal of different categories of healthcare waste. Burial is the most common method for general waste (70%), sharp waste (50%), and pharmaceutical waste (20%). Placenta pit is the most common method for liquid waste (80%). Municipality support is used for the disposal of

some categories of waste, with varying percentages: general waste (20%), hazardous waste (20%), sharp waste (20%), radioactive waste (20%), and pharmaceutical waste (20%). One of the hospitals utilized the services of a private organization for the transport and management of general waste (10%), sharp waste (10%), radioactive waste (10%), and pharmaceutical waste (10%).

Discussion

The practices of healthcare waste management (HCWM) in specific healthcare facilities (HFs) of Kailali district were examined in this study, employing a cross-sectional design to provide a comprehensive assessment. The findings revealed a range of practices, with varying levels of compliance and effectiveness, including some facilities demonstrating good HCWM practices while others requiring significant improvements.

The study revealed that outpatient and inpatient numbers varied significantly across hospitals and health posts, likely due to differences in services, capacity, and population density. This variation in patient volume and service provision has significant implications for waste management, as larger health facilities with more extensive inpatient services generate considerably more waste, necessitating robust waste management systems (Wei et al., 2021; Prasad et al., 2022).

Waste generation also varied significantly among the facilities, with one hospital generating over fifty kilograms of waste per day, highlighting the importance of efficient and responsible waste management practices in such settings. These variations underscore the need for tailored waste management strategies that consider the specific needs and circumstances of each facility.

The study also found variations in waste segregation practices, reflecting disparities in resource availability, adherence to national guidelines, and staff understanding of proper protocols. The lack of standardization in pharmaceutical waste segregation and the frequent use of placenta pits for liquid waste disposal raise concerns about environmental contamination and the spread of infections (Kwikiriza et al., 2019).

Waste collection practices also varied across facilities, with differences in container types, collection frequency, and transportation methods. While the high prevalence of covered waste collection containers is positive, the variations in collection frequency suggest a lack of standardized protocols. The universal reliance on human resources for waste transportation may pose ergonomic risks and limit efficiency (Proia et al., 2022).

Waste storage practices were generally positive, with good lighting, ventilation, drainage, water supply, and needle-proof containers across all facilities. However, the absence of impermeable floors in most facilities raises concerns about potential contamination. The lack of secured and lockable storage areas in most facilities is also a significant concern.

The study found that ninety of healthcare facilities practiced some form of waste treatment before disposal, but the choice of treatment methods raised concerns. The reliance on burial and burning in many facilities raises environmental and public health concerns (Abdurrahman et al., 2020; Siddiqua et al., 2022). The relatively low adoption of autoclaving or sterilization may be due to higher costs and technical expertise required.

Final disposal methods varied across different waste categories, with burial being frequently employed despite concerns about potential soil and groundwater contamination (Siddiqua et al., 2022). The use of placenta pits for liquid waste disposal warrants further investigation. The reliance on

municipality support for certain waste categories underscores the need for strengthened collaboration between healthcare facilities and local authorities (Kulkarni & Anantharama, 2020).

This study provides a comprehensive evaluation of practices on healthcare waste management in healthcare facilities of Nepal, revealing varying levels of compliance and effectiveness. The significant variation in patient volume and service provision across hospitals has significant implications for waste management, as larger hospitals generate considerably more waste, necessitating robust waste management systems. The study also found variations in waste generation, segregation practices, collection practices, storage practices, treatment methods, and final disposal methods, highlighting the need for tailored waste management strategies that consider the specific needs and circumstances of each facility (de Aguiar Hugo & Lima, 2021; Hantoko et al., 2021).

Several implications can be drawn from this research for policy and programs on healthcare waste management, both globally and in developing countries like Nepal. First, the study highlights the need for standardized waste management protocols, including waste segregation, collection, storage, treatment, and disposal. These protocols should be tailored to the specific needs and circumstances of each healthcare facility, considering factors such as patient volume, service provision, and resource availability (Aziz et al., 2022; Hantoko et al., 2021). Second, the study underscores the significance of staff training and awareness programs to ensure proper understanding and adherence to waste management protocols (Das et al., 2021). Regular training and monitoring can help improve compliance and reduce risks to healthcare workers and the environment (de Aguiar Hugo & Lima, 2021). Third, the research emphasizes the need for improved infrastructure and resource availability to support effective waste management practices. This includes providing adequate waste segregation containers, collection and transportation systems, and treatment and disposal facilities (Akkajit et al., 2020; Das et al., 2021).

The results of this investigation are in accordance with those of prior investigations conducted in Nepal and other developing countries, which have also reported similar challenges in healthcare waste management (Hantoko et al., 2021; Das et al., 2021; Akkajit et al., 2020; Karki et al., 2020; Neves et al., 2022b; Nepal et al., 2023; Slutzman et al., 2023). From an occupational health and safety perspective, this research underscores the critical need for improved waste management practices in healthcare facilities to minimize risks to healthcare workers. The variations in waste segregation, collection, and storage practices, coupled with the reliance on manual transportation and unsafe disposal methods like burial and burning, can lead to potential exposure to hazardous waste, increasing the risk of infections and injuries. The study highlights the importance of investing in appropriate infrastructure, such as secured and pest-proof waste storage areas, and providing comprehensive staff training on proper waste management protocols and PPE use. By addressing these key areas, healthcare facilities can enhance occupational health and safety, reduce the potential for workplace injuries and illnesses, and create a safer and healthier environment for healthcare workers.

However, this study has several limitations. The small sample size and the focus on a single district in Nepal limit the generalizability of the findings in diverse settings. Furthermore, the investigation depended on self-reported data and observations, which may be susceptible to bias. Forthcoming research should consider larger-scale studies across multiple regions and countries, employing more rigorous data collection methods to provide a more comprehensive understanding of healthcare waste

management practices and their impact on public health and the environment.

In light of these constraints, this study offers important perspectives on the challenges and opportunities for improving healthcare waste management practices in Nepal and other developing countries. By addressing the key areas of concern identified in this study, healthcare facilities can make significant strides towards achieving safe and effective healthcare waste management, promoting health and safety of health workers, protecting public health and safeguarding the environment.

Conclusion

This study revealed significant variations in healthcare waste management (HCWM) practices across different healthcare facilities in Nepal, highlighting the need for context-specific strategies. Findings underscore the importance of standardized HCWM protocols tailored to individual health facility needs, comprehensive staff training, and investment in adequate infrastructure and resource availability. These measures are crucial to ensure safe and effective HCWM, minimizing public health risks and environmental pollution. Addressing these key areas, healthcare facilities in Nepal and similar settings can enhance occupational health and safety, reduce the potential for workplace injuries and illnesses, and create a safer and healthier environment for healthcare workers.

Despite limitations in scope, this research provides valuable insights into the opportunities and challenges for improving HCWM in resource-constrained settings. Future research should expand on these findings through larger-scale studies with more robust data analysis to further inform policy and practice improvements in Nepal and other developing countries.

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