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Optimizing Medical Waste Management in Primary Healthcare: A Hands-On Workshop for Safer and Sustainable Practices

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ABSTRACT

The management of medical waste in primary healthcare facilities is a critical issue due to its potential impact on public health and the environment. Improper handling of medical waste can lead to the spread of infectious diseases, environmental pollution, and risks to healthcare workers and communities. However, many primary healthcare facilities, particularly in developing countries, face challenges such as inadequate infrastructure, insufficient training, and limited resources. This workshop aimed to address these gaps by using role-playing simulations to provide healthcare workers with practical knowledge and skills in managing medical waste. Participants were divided into groups to simulate scenarios involving waste segregation, storage, transportation, and coordination among stakeholders. The results highlighted the importance of proper waste classification, effective communication, and the use of technology to improve efficiency. Participants also identified key challenges, such as limited storage facilities and poor coordination, and proposed practical recommendations, including regular training, increased infrastructure, and digital tracking systems. This workshop demonstrated that structured interventions can enhance medical waste management practices, ensuring safer healthcare environments and better compliance with international standards.

KEYWORDS

Medical waste management, primary healthcare, role-playing simulation, waste segregation, stakeholder collaboration

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INTRODUCTION

The management of medical waste in primary healthcare facilities is a critical issue that requires attention due to its potential impact on public health and the environment (Singh et al., 2022). Medical waste, if not handled properly, can lead to the spread of infectious diseases, environmental pollution, and harm to healthcare workers and the community (World Health Organization, 2025). In many developing countries, primary healthcare facilities often lack adequate infrastructure, training, and resources to manage medical waste effectively (Prüss-Ustün et al., 2017). This highlights the need for structured interventions such as workshops to equip healthcare workers with the necessary knowledge and skills to handle medical waste safely and efficiently (Lee & Lee, 2022). By addressing these gaps, healthcare facilities can minimize risks and ensure compliance with international standards (Sahoo et al., 2024).

Primary healthcare facilities, such as puskesmas (community health centers) and clinics, play a vital role in delivering essential health services to communities. However, these facilities are often faced with challenges in managing medical waste due to limited budgets, inadequate training, and insufficient regulatory enforcement (Windfeld & Brooks, 2015). For instance, improper segregation of waste, lack of proper storage facilities, and infrequent waste collection can exacerbate the problem. According to Yiğit Hunce et al. (2020), integrating digital tools and standardized protocols into waste management systems can significantly improve efficiency and accountability. Workshops focused on medical waste management can serve as a platform to introduce these innovations while also addressing the root causes of inefficiencies in current practices (Singh et al., 2022).

Training and capacity-building initiatives are essential to improving medical waste management in primary healthcare settings. Studies have shown that healthcare workers often lack sufficient knowledge about waste classification, handling, and disposal procedures (Akkajit et al., 2020). This knowledge gap can lead to errors such as mixing hazardous waste with general waste, which poses significant risks to both human health and the environment (Zhang et al., 2022). To address this, workshops can incorporate interactive methods like role-playing simulations, which have been proven effective in enhancing learning outcomes and practical skills (Ben Jmaa et al., 2023). Such approaches not only engage participants but also provide them with hands-on experience in managing real-world scenarios.

Collaboration among stakeholders is another key factor in ensuring the success of medical waste management programs (Dixit et al., 2023). Effective waste management requires coordination between healthcare facilities, waste transporters, regulatory bodies, and local governments (World Health Organization, 2025). Unfortunately, poor communication and lack of collaboration often hinder the implementation of efficient waste management systems (Prüss-Ustün et al., 2017). Workshops can facilitate dialogue and foster partnerships among these stakeholders, enabling them to work together toward common goals. By promoting awareness, providing practical solutions, In many developing countries, primary healthcare facilities often lack adequate infrastructure, training, and resources to manage medical waste effectively (Prüss-Ustün et al., 2017) and encouraging stakeholder engagement, workshops on medical waste management can contribute significantly to creating safer and more sustainable healthcare environments.

MATERIALS AND METHODS

Steps of Implementation

1. Preparation of Scenarios

The first step in the implementation of the activity was to develop medical waste management case scenarios (Awodele et al., 2016). These scenarios were designed to cover various medical waste management conditions that are often encountered in first-level health facilities, such as:
Infectious waste from the procedure room: A nurse must safely dispose of used syringes and medical devices from patients. Expired pharmaceutical waste: A pharmacist finds expired medicines that must be destroyed according to procedure. Contaminated non-medical solid waste: A cleaner must clean the waste from the COVID-19 patient isolation area (Das et al., 2021).

Each scenario is organized in detail, including: Type of waste: A brief description of the type of waste to be managed, starting facility: For example, a health center or primary clinic, management objectives: sorting process, temporary storage, and transportation to the final processing site. Potential challenges: limited waste storage facilities, lack of staff understanding of procedures, or lack of communication between work units.

In addition, the roles to be played by the participants were clearly defined, namely:

1. Waste Sorting Officer: Responsible for sorting waste according to category (infectious, non-infectious, pharmaceutical, etc.).
2. Waste Management Coordinator: In charge of ensuring the waste management process is in accordance with procedures and coordination with external parties (e.g. waste transportation service providers) (Stanojević et al., 2022).
3. Cleaning Officer: In charge of cleaning the work area and ensuring waste is not leaked or dispersed.
4. Facility Supervisor: Ensure all procedures are implemented correctly and provide direction to the team.

2. Simulation Execution

Once the scenario and roles are prepared, the simulation is carried out with the following steps:

1. Time Distribution:

   Each group is given 4 minutes to carry out the simulation. A timer is used to ensure all groups follow the predetermined time limit.

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2. Simulation Implementation:
   Participants should work together to solve medical waste management problems according to the given scenario, examples of tasks to be completed during the simulation, determine the waste category: Is the waste infectious, non-infectious, or pharmaceutical, ensuring waste segregation: Has the waste been put into the right container?, coordinating waste transportation: Is a waste transportation service provider available?, ensuring environmental safety: Has the work area been properly cleaned?, during the simulation, participants should interact with each other according to their roles. For example, the waste sorting officer should communicate with the waste management coordinator to ensure the process runs smoothly.
3. Monitoring:
   The activity organizer monitors the course of the simulation to ensure all participants are actively involved and the scenario is running as planned.

3. Reflection

After all groups have completed the simulation, a 5-minute reflection session is conducted. This reflection aims to evaluate the results of the simulation and identify important lessons learned by the participants. Reflection steps include:

1. Brief Discussion:
   - The organizer asks participants reflective questions, such as:
   - "What were the main challenges you faced during the simulation?"
   - "How did you overcome the problems that arose?"
   - "What are the important lessons you learned from this simulation?"
   - Participants are asked to answer these questions briefly but concisely.
2. Problem Identification:
   - Participants were asked to identify obstacles that often arise in the medical waste management process, such as:
   - Lack of understanding of the waste category.
   - Limited waste storage facilities.
3. Practical Recommendations:
   - Based on the results of the reflection, participants were asked to provide practical recommendations to improve the medical waste management system in primary care. For example:
   - Provide regular training for staff on medical waste management procedures.
   - Adding standardized waste storage facilities.
   - Improve communication between work units in waste management.

Tools and Materials

1. Waste Sorting Form:

   Used by waste sorting personnel to document waste type, quantity, and management purpose,

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the form also includes columns for important notes, such as sorting date and officer's name.

2. Simulated Waste Containers:
   Containers labeled with different colors (red for infectious waste, yellow for pharmaceutical waste, black for non-medical waste) are used to simulate the waste segregation process (Tank & Khambhati, 2021).
3. Timer:
   Used to set the simulation time for each group so as not to exceed the specified time limit.
4. Role Cards:
   Role cards were given to participants to facilitate understanding of the duties of each role, a toy phone or a simple chat app is used to simulate communication between a waste management coordinator and a waste hauling service provider.

RESULTS AND DISCUSSION

Simulation Outcomes

After the implementation of the simulation with the theme Workshop on Medical Waste Management in First Level Health Facilities, the results obtained reflected the participants' understanding of the dynamics of medical waste management. Most groups managed to sort waste appropriately according to categories (infectious, non-infectious, pharmaceutical, etc.) using color-labeled containers, although some groups had difficulty in identifying certain types of waste, such as non-medical solid waste contaminated with infectious liquids. Coordination between roles was also an important factor in this simulation; groups with effective communication between waste sorters, waste management coordinators, and cleaners completed the task more quickly and accurately, while groups with weak coordination experienced obstacles such as delays in contacting waste transportation service providers or errors in sorting procedures. In terms of time efficiency, the majority of groups managed to complete the simulation within the prescribed 4 minutes, but some groups needed additional time due to lack of understanding of the workflow or unavailability of the simulated facilities, such as full waste containers. In addition, participants were also able to identify common challenges in medical waste management, such as lack of adequate waste storage facilities, lack of training for staff on waste classification, and poor coordination between work units.

Reflection Insight

1. Short Discussion

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In the reflection session, participants were asked to answer reflective questions posed by the organizers, and from the discussion several important insights emerged. One of the main challenges expressed by participants was the difficulty in differentiating between infectious and non-infectious waste, especially when they have a similar appearance. In addition, communication between teams often breaks down due to the absence of a clear system to coordinate. To address these issues, some participants tried prioritizing tasks so that all team members know what to do, as well as using waste segregation forms to document each step to make the process more structured. From this simulation, participants also learned important lessons, such as the need for precision in waste segregation as small mistakes can have a big impact on the environment. They also realized that coordination between work units is crucial to ensure that waste does not accumulate and is transported immediately.

2. Problem Identification

Participants actively identified problems that often arise in medical waste management in primary healthcare facilities. Some of the key issues expressed included limited storage facilities, such as waste containers that are often full due to the infrequent frequency of waste transportation, as well as the absence of a dedicated space to store waste before transportation in some puskesmas. In addition, lack of training is also an obstacle, with many officers not fully understanding the classification of medical waste and management procedures sometimes unclear due to the lack of official guidelines. Another issue is the lack of communication, where there is often no good communication between the puskesmas and the waste transportation service provider, and cleaners often do not know what to do if waste is leaked or scattered.

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3. Practical Recommendations

Based on the reflection results, participants provided practical recommendations to improve the medical waste management system in first-level health facilities. One recommendation was the provision of adequate facilities, such as increasing the number of waste containers according to WHO standards (red for infectious, yellow for pharmaceutical, black for non-medical) as well as providing a special storage room for medical waste before transportation. In addition, regular training is also proposed, including conducting periodic trainings for health workers on medical waste classification and management procedures, as well as distributing a simple guide that can be used as a daily reference. Improved communication is also a focus, by establishing a better communication system between puskesmas and waste transportation service providers, as well as using digital applications to track the status of waste (e.g., sorted, stored, or transported). Finally, community education is also recommended, such as educating patients and families on the importance of medical waste segregation, especially outpatient household waste.

Based on the simulation results and reflections in the Workshop on Medical Waste Management in First Level Health Facilities, this discussion aims to dig deeper into the challenges, solutions, and practical recommendations that can be applied in medical waste management. One of the main points that emerged was the importance of proper waste segregation. According to research by World Health Organization (2025) medical waste segregation is a critical step in minimizing the risk of environmental pollution and disease transmission. However, the simulation results show that sorting errors often occur due to the officers' lack of understanding of waste classification. This suggests the need for regular training and visual guidance such as posters or color labels to help staff distinguish waste types more accurately(Prüss-Ustün et al., 2017). In addition, an internal audit system can also be used to ensure compliance with sorting procedures.

The effectiveness of communication between roles was also highlighted in this discussion. Poor communication between waste sorters, coordinators, and waste transportation service providers often leads to bottlenecks in the waste management process. Research by Yiğit Hunce et al. (2020) shows that the use of digital technologies, such as waste tracking applications, can improve communication efficiency and ensure that waste is transported immediately after reaching the maximum capacity of storage containers. Workshop participants recommended the implementation of such a system, although challenges such as budget constraints and the learning curve of new technologies need to be considered. Therefore, additional training for officers is necessary to ensure smooth adoption of the technology.

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Limited waste storage facilities were also one of the main challenges identified in the simulation. Fast-filling waste containers and inadequate storage space often lead to a buildup of waste, which poses potential health risks (Windfeld & Brooks, 2015). To address this issue, participants recommended increasing the number of waste containers to WHO standards as well as procuring dedicated storage space as a long-term solution. In addition, health facilities can also collaborate with third parties to increase the frequency of waste transportation, thereby reducing the risk of accumulation.

Training and education for staff was also a focus of discussion. The lack of regular training and official guidelines means that many staff do not fully understand medical waste management procedures (Akkajit et al., 2020). Participants suggested interactive training such as role-playing simulations and distribution of simple guidelines that can be accessed daily. In addition, education to the community is also important, especially in terms of sorting out outpatient household medical waste. By increasing public awareness, the burden of medical waste management in healthcare facilities can be reduced.

Finally, collaboration across units and stakeholders is key to the success of medical waste management. Poor collaboration between work units and external stakeholders often causes the waste management process to not run smoothly (Ben Jmaa et al., 2023). Participants suggested establishing regular coordination forums between puskesmas and waste transportation service providers to ensure effective communication. The government also has an important role in supporting this collaboration through clear regulations and adequate funding.

From this discussion, it can be concluded that medical waste management in primary healthcare facilities requires a holistic approach that includes training, infrastructure, technology, and cross-sector collaboration. With the implementation of these recommendations, it is expected that health facilities can reduce the risk of environmental pollution and protect public health more effectively.

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Fig. 2: Workflow of Medical Waste Segregation in Primary Healthcare Facilities

Table 1: Categories of Medical Waste Managed in Primary Healthcare Facilities
(This is the Table Head)

WASTE TYPE	DESCRIPTION	EXAMPLES	DISPOSAL METHOD
Infectious Waste	Waste contaminated with blood or pathogens	Used needles, bandages, swabs	Autoclaving, incineration
Pharmaceutical Waste	Expired or unused medications	Pills, vials, ampoules	High-temperature incineration
Sharps	Items that can cause cuts or punctures	Needles, scalpels, broken glass	Safe disposal in puncture-proof containers
General Waste	Non-hazardous waste similar to household waste	Paper, food scraps, packaging materials	Landfill disposal

CONCLUSIONS

The role-playing simulation in this medical waste management workshop successfully provided participants with practical insights into the challenges and solutions in medical waste management in first-level health facilities. Through reflection, participants not only understood the importance of sorting and coordination, but also came up with concrete recommendations to improve the medical waste management system in the field. With the implementation of these recommendations, it is expected that first-level health facilities can reduce the risk of environmental pollution and protect public health more effectively.

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