


# Exploring waste disposal knowledge and practices of pharmacists and nurses at a selected hospital in South Africa

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**Background.** The correct disposal of healthcare waste is vitally important to protect the environment and public health. Improperly disposed of medical waste can endanger health by polluting the environment, affecting the quality of water resources and transmitting disease.

**Objectives.** To explore the knowledge and practices of pharmacists and nurses regarding waste disposal at a selected hospital in South Africa.

**Methods.** A quantitative design was used for the study. A stratified random sampling method was adopted to select participants, and convenience sampling was used to select the hospital. Data were obtained using a closed-ended questionnaire. The data were analysed using descriptive statistics with percentages and frequencies, which were presented in graphs and tables. A total sample size of 280 healthcare workers was used.

**Results.** A total of 280 nurses and pharmacists participated in the study, with a response rate of 100%. Most of the participants were female. The majority ( $n=112$ ; 40.0%) were aged between 30 and 39 years. Most ( $n=252$ ; 90.0%) understood that medical and general waste should be disposed of separately; to prevent injuries, 244 (87.1%) would dispose of injection syringes in a sharps disposal container, 274 (97.9%) would dispose of injection needles in a sharps disposal container, and 218 (77.9%) would dispose of empty medicine vials in a sharps disposal container; and 278 (99.3%) understood proper disposal of gloves contaminated with blood to prevent infections.

**Conclusion.** Most of the participants understood that medical and general waste should be disposed of separately, and they understood and identified proper sharps disposal methods to prevent injuries. Overall, waste disposal knowledge and practice were satisfactory. However, ongoing education and training are recommended to close any gaps in knowledge and encourage consistent practice.

**Keywords.** General waste, gloves, infectious waste, injection needles, medical waste, nurses, pharmacists, sharps waste, vials, waste disposal.

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*Author bios: This research project was undertaken as a requirement for completion of the BPharm degree at Sefako Makgatho Health Sciences University. The student team, Angela Mello, Faith Masocha, Innocent Lubisi and Madikologe Mokobane, are now pharmacists working in retail and hospital pharmacies. They graduated in 2024 and showed interest in hospital and community pharmacy practice as students. The project was undertaken with support and guidance from Ms Pertunia Mushasha (supervisor) and Ms Nontobeko Shabangu (co-supervisor).*

In South Africa (SA) and most countries worldwide, healthcare waste management is a serious problem. Improper disposal of healthcare waste can affect the environment, causing land and water pollution that causes diseases such as cholera and typhoid fever. Healthcare waste in SA can come from a variety of sources, including hospitals, clinics and laboratories.<sup>[1]</sup> The improper disposal of healthcare waste has been associated with several health risks, the spread of infectious diseases, and contamination of the water in rivers and lakes. It is therefore essential to investigate the healthcare waste knowledge and practices of healthcare workers in SA.<sup>[1]</sup>

In hospitals, hazardous waste includes pharmaceuticals, cytotoxic drugs, radioactive materials and chemotherapy drugs. All these have the potential to cause harm if not disposed of properly.<sup>[2]</sup> The main categories of biomedical waste in hospitals are sharps, infectious waste,

pathological waste and pharmaceutical waste. Sharps are any items that can puncture or cut the skin, such as needles, scalpels and other pointed or cutting instruments. Infectious waste includes items that are contaminated with blood or other bodily fluids, such as bandages, dressings and gloves. Pathological waste includes items such as organs, tissues and body parts.<sup>[3]</sup>

A study carried out in Gauteng Province, SA, found that healthcare workers did not adequately comprehend the dangers related to improper disposal of healthcare waste.<sup>[4]</sup> This finding is consistent with the challenges highlighted in a report on waste management opportunities in the West Rand District Municipality, Gauteng, which outlines key initiatives to address such issues.<sup>[5]</sup> There is a need for improved instruction on the regulation of healthcare waste in SA, as disposal of potentially harmful products requires permission and supervision.

Understanding healthcare waste management is critically important because improper handling poses substantial risks to both public health and the environment. It can lead to the spread of infectious diseases, contaminate vital resources such as land and water, and endanger healthcare workers themselves. Research in this area is therefore essential for developing effective policies, training programmes and interventions that promote safe and sustainable waste disposal practices, ultimately safeguarding communities and preserving environmental integrity.

The objective of the present study was to explore the waste disposal knowledge and practices of pharmacists and nurses at a selected hospital in SA.

## Methods

### Study design

The study design was analytical and quantitative.

### Study site

This study was conducted in Tshwane, Gauteng. The Tshwane district has three tertiary hospitals. One tertiary academic hospital was selected as the study site. This institution serves as a tertiary referral centre in the Tshwane region. It is a teaching hospital affiliated to one of the health science tertiary institutions in the province, providing both primary and tertiary healthcare services to a catchment population of approximately 1.2 million people. As a key institution for training pharmacists, nurses and other healthcare professionals, the selected hospital provides a robust academic environment where healthcare staff are regularly engaged in professional development. It was therefore an ideal setting for studying the knowledge and practices of healthcare workers in terms of waste disposal, as it offers access to a broad range of experienced and trainee healthcare professionals.

### Study population

The study population consisted of pharmacists and permanent nurses in various categories at the selected hospital, which had a total of 2 210 nurses and 43 pharmacists. The study included nurses because they are a key part of the healthcare team in the hospital environment and play an important role in the disposal of medical waste. Nurses are often responsible for collecting and sorting waste, and may also be involved in transporting and disposing of hazardous waste.

A Raosoft sample size calculator, 2004 (Raosoft Inc., USA), was used to determine the minimum sample size for the selected hospital after obtaining the total number of nurses and pharmacists from the hospital. The sample size was calculated using 90% confidence, with a 50% proportion and a 5% margin of error. The number of permanent nurses was 242 and the number of pharmacists 38, which gave a total sample of 280.

### Sampling of the participants

Stratified random sampling was used to select participants for the study. This meant that everyone had the same chance of being selected to participate, which helped reduce the risk of selection bias and increased the reliability of the study. The researchers also considered the potential for observer bias, which occurs when the person collecting the data influences the results.

The potential participants were first divided into distinct groups or strata, based on their qualifications, such as permanent nurses and

pharmacists. After defining these strata, the sample was determined for each group. Within each stratum, participants were randomly selected by using paper slips with numbers written on them. The slips were folded and placed in a container. Each potential participant drew a slip, and those who selected a slip with a number corresponding to their stratum were included in the study.

The inclusion criteria for the study were permanent nurses and pharmacists. Exclusion criteria were pharmacist assistants and non-permanent nurses.

### Data collection process

The data were collected using a hard-copy questionnaire, which is a good way to reach a wide range of people, especially those who may not have access to the internet. The paper forms were properly disposed of by recycling after data collection. The questionnaire consisted of a series of closed-ended questions on the topic of interest. It had two sections, where section A consisted of demographic data, and section B had questions about the knowledge and practices of healthcare workers regarding waste disposal. As shown by a practice run, completion of the questionnaire with a consent form took less than 3 minutes.

The questionnaire was adapted from others described in the literature.<sup>[6-8]</sup>

To ensure that participants did not complete a questionnaire twice, the four student researchers went to different wards on the same day and time.

### Pilot study

A pilot study was conducted among 24 non-permanent nurses and four pharmacists in the same hospital. This number was determined using a general 10% rule, according to which the sample size for a pilot study should be 10% of the expected sample size for the full-scale study.<sup>[9]</sup> The pilot study was done to test whether the questionnaire was clear, understandable and suitable for the target participants, and would effectively measure knowledge and practices related to waste disposal. No changes were made to the questionnaire before actual data collection started. The responses in the pilot study were not included in the final data.

### Statistical analysis

After the data were collected, they were digitised by entering them into a spreadsheet or database (Excel 2024; Microsoft Inc., USA). Possible errors were rectified before transferring into statistical software, SPSS statistics for Windows, version 27.0 (IBM Corp., USA), for analysis. Descriptive data analysis was used. The data were analysed using percentages and frequencies and presented using graphs, pie charts and tables.

### Ethical considerations

The research protocol was approved by the university research committee. The researchers sought ethical clearance from the Sefako Makgatho University Research and Ethics Committee and the School of Pharmacy Research Committee, which granted ethical clearance and approval (ref. no. SMUREC/P/202/2024:UG). Approval from the hospital's CEO was also requested and granted. Before collecting data from the study participants, the researchers ensured that the participants had been given full and clear information on the purpose of the study. The participants gave their signed consent freely, without any pressure or coercion. The researchers also ensured and let participants know that the collected data would be anonymous and

treated with confidentiality, and would only be used for the purposes of the study.

## Results

Of 280 study participants, the majority were nurses ( $n=242$ ; 86.4%), while 38 (13.6%) were pharmacists (Table 1).

### Demographic data

The majority of the participants ( $n=112$ ; 40%) were aged 30 - 39 years; 78 (27.9%) were aged 40 - 49 years, 43 (15.4%) were aged 50 - 59 years, 42 (15.0%) were aged 20 - 29 years, and 5 (1.8%) were aged 60 - 65 years. The majority of the participants ( $n=248$ ; 88.6%) were women, and 32 (11.4%) were men.

### Separation of medical waste from general waste

The responses indicated that the majority of the participants ( $n=252$ ; 90.0%) were of the opinion that medical waste and general waste should be disposed of separately, with a minority ( $n=28$ ; 10.0%) suggesting that it should all be disposed of together (Fig. 1).

### Disposal of used injection syringes

Of the participants, 244 (87.1%) believed that used injection syringes should be disposed of in sharps disposal containers, 19 (6.8%) that general waste containers should be used, 13 (4.6%) that medical waste containers should be used, and 4 (1.4%) that pharmaceutical waste containers should be used (Fig. 2).

### Disposal of used injection needles

The responses indicated that the majority of the participants ( $n=274$ ; 97.9%) would dispose of injection needles in a sharps disposal container, while 5 (1.8%) would use a pharmaceutical waste container and 1 (0.4%) a general waste container (Fig. 3).

### Disposal of gloves contaminated with blood

The responses indicated that the majority of the participants ( $n=278$ ; 99.3%) would dispose of gloves contaminated with blood in a medical waste container, while 1 (0.4%) would use a sharps disposal container and 1 (0.4%) a general waste container (Fig. 4).

**Table 1. Demographic data (N=280)**

Demographic characteristics	n (%)
Gender	
Male	32 (11.4)
Female	248 (88.6)
Age (years)	
20 - 29	42 (15.0)
30 - 39	112 (40.0)
40 - 49	78 (27.9)
50 - 59	43 (15.4)
60 - 65	5 (1.8)
Occupation	
Permanent pharmacists	38 (13.6)
Permanent nurses	242 (86.4)

### Disposal of vials after withdrawing medication

The responses indicated that the majority of the participants ( $n=218$ ; 77.9%) would dispose of empty medicine vials in a sharps disposal container, 25 (8.9%) in a medical waste container, 21 (7.5%) in a general waste container, and 16 (5.7%) in a pharmaceutical waste container (Fig. 5).

## Discussion

Of the 280 study participants, 242 were nurses and only 38 were pharmacists. This imbalance may help explain why nursing viewpoints predominate in the findings, and the results therefore cannot necessarily be generalised to pharmacists. Most of the participants were female, owing to the gender distribution in nursing. The preponderance of females could have affected the study results, as women's opinions were represented most frequently. The results follow the same pattern as was found in a study conducted in Bangladesh hospitals on disposal of sharp medical waste by nurses and cleaners, although in that study most participants were male (70%) and aged 40 - 49 years (44.5%).<sup>[10]</sup>

With regard to waste disposal, most of the participants (90%) were in support of the view that medical waste should be disposed of separately from general waste, while only 10% thought that medical waste could be disposed of together with general waste. It is evident that most of the healthcare workers were aware of the importance of waste segregation, especially to minimise the hazards arising from the mingling of clinical and non-clinical waste.

These results are consistent with those of the study on disposal of sharp medical waste,<sup>[10]</sup> in which the majority of the participants ( $n=322$ ; 78.7%) knew that medical waste should be separated and classified to avoid injuries and infections.

Of all the participants in the present study, 87.1% disposed of used injection syringes in sharps disposal containers, as is recommended to avoid needle pricks and cross-infection. This high figure is another strong sign of the hospital's compliance with correct safety procedures. Only 1.4% reported using pharmaceutical waste containers. Although

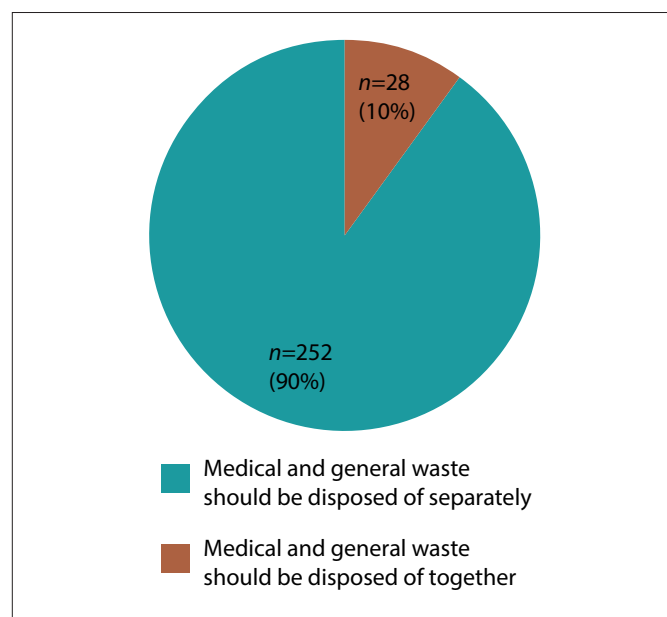


Fig. 1. Participants' responses on the need for separate disposal of medical and general waste.

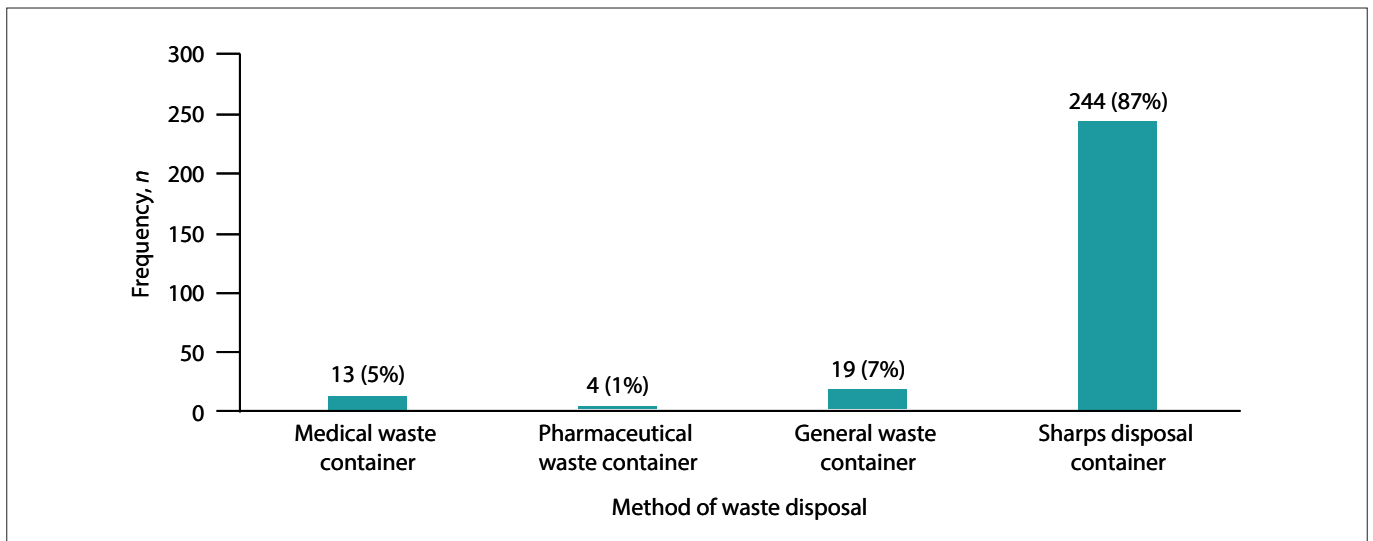


Fig. 2. Participants' responses on proper disposal of used injection syringes.

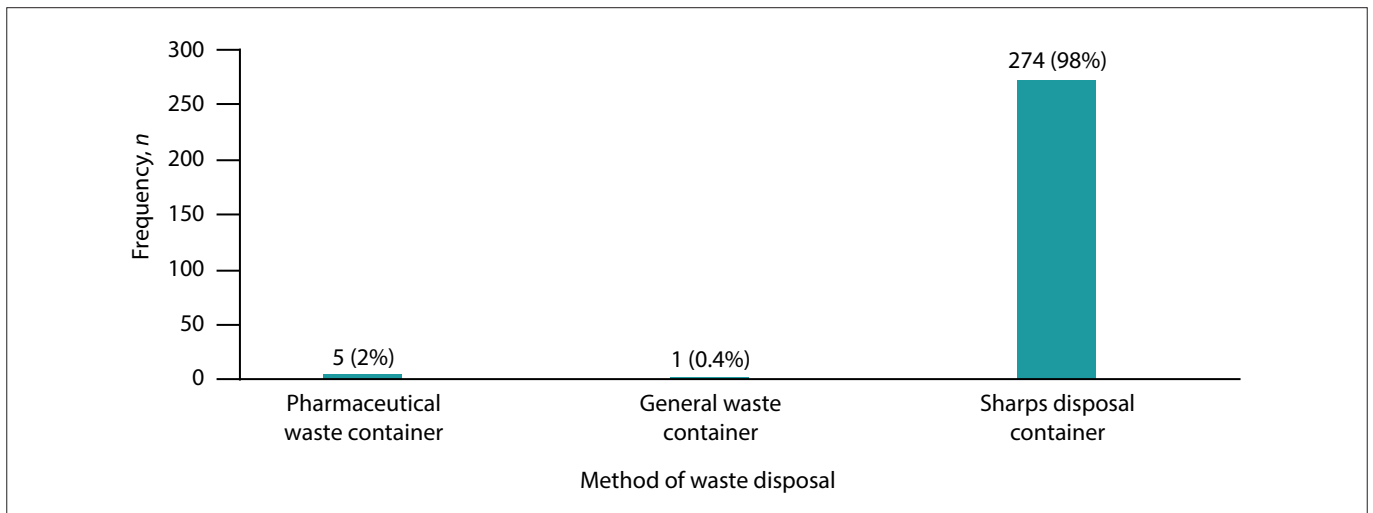


Fig. 3. Participants' responses on proper disposal of used injection needles.

other waste containers provide some protection against cross-infection, they are not intended for sharps, and there is a risk of an accidental needle prick or contamination if sharp objects are disposed of in them. This small gap in practice, i.e. the incorrect disposal of sharps, by a minority of participants highlights the need for continued staff training and monitoring to ensure full adherence to infection prevention standards. Similar results were seen in a study on medical waste disposal at a hospital in Mpumalanga Province, SA,<sup>[7]</sup> where 90% of participants knew the correct container in which to dispose of sharp medical waste.

Most of the participants in the present study (97.9%) correctly disposed of used injection needles in sharps disposal containers, which shows that they adhered to safety measures intended to stop cases of needle stick injuries and cross-contamination. This finding indicates a high level of awareness and adherence to standard medical waste disposal practices, as is required to avoid compromising the safety of health facilities. However, a small percentage of participants disposed of needles incorrectly. These improper disposal practices are dangerous, firstly because staff may

suffer injuries while handling waste, and secondly because recyclable materials may become contaminated by waste, making them unusable. The results of the present study are similar to the finding of Samadder *et al.*<sup>[10]</sup> that most participants (90.0%) knew the correct bin in which to dispose of sharp medical waste.

We found that a very high proportion of the participants in the present study (99.3%) disposed of blood-contaminated gloves in a medical waste container, which is the correct practice when dealing with waste contaminated by fluids or blood. It shows good practice in applying the rules of infection control, minimising possible exposure to contaminants and transmission of disease. However, the fact that 0.4% of the participants disposed of contaminated gloves in general waste containers is of concern, as they are not complying with standard biohazard waste disposal practices. Disposing of contaminated gloves in a puncture-resistant container is inappropriate, as these containers are intended for sharp items. Similarly, using a normal recycling bin is very risky because it poses a hazard to waste handlers, in addition to the chance of cross-contamination.

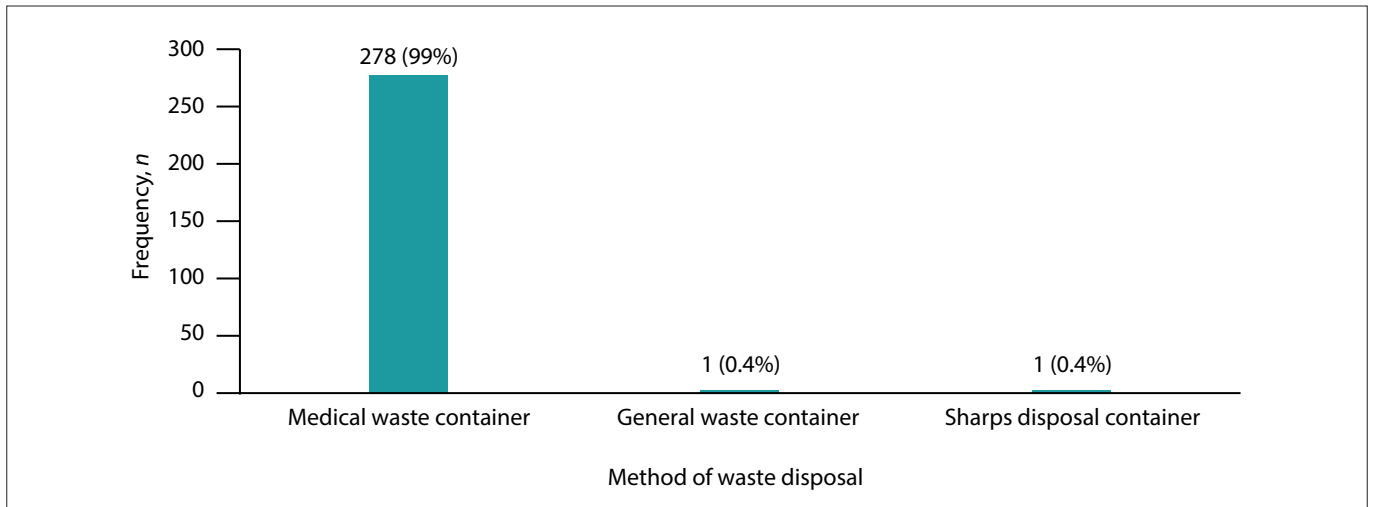


Fig. 4. Participants' responses on proper disposal of gloves contaminated with blood.

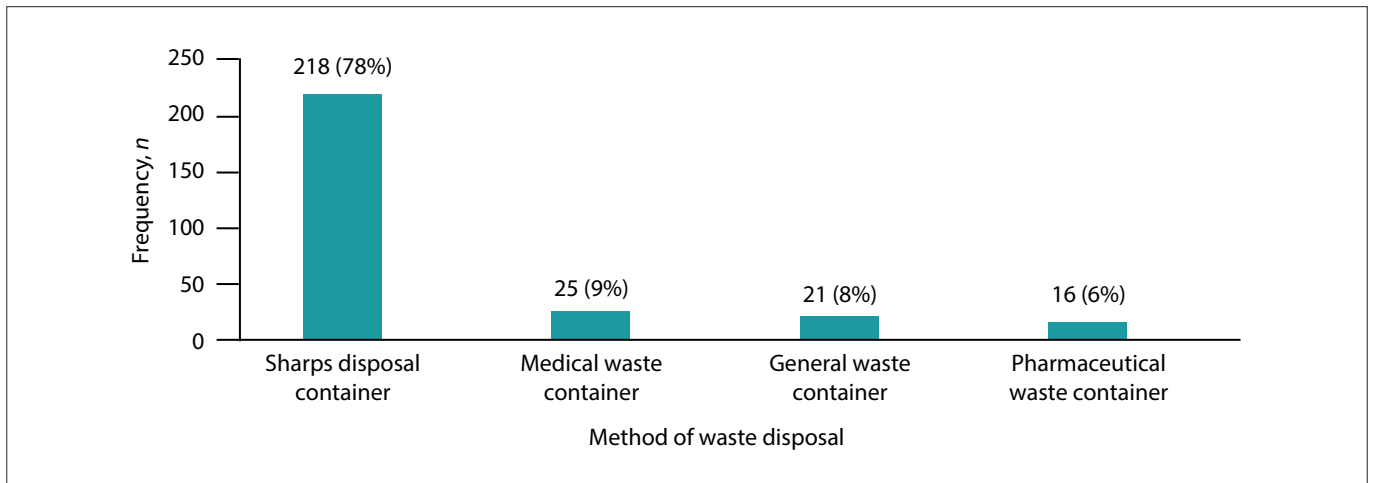


Fig. 5. Participants' responses on proper disposal of vials after withdrawing medication.

Most of the participants in our study (77.9%) disposed of empty vials in sharps disposal containers, which is the correct procedure in dealing with objects that are potentially dangerous because they can cause puncture. This finding suggests good adherence to safety measures by making sure that potentially hazardous products are handled in a way that will avoid harm or pollution of the environment. However, a notable proportion of the participants used incorrect disposal methods: 8.9% said that they discarded vials in medical waste containers, 7.5% used general waste containers, and 5.7% used pharmaceutical waste containers. These methods are not suitable for vials because, apart from containing a residue of whatever was in them, vials are made of glass or hard plastic material, which may present physical hazards. Use of incorrect containers for disposal of sharps also poses a risk to healthcare providers and waste handlers, as they can be injured by the needles in the container.

Our study findings indicate that although most of the participants used the recommended procedures, more awareness and guidance are required for appropriate disposal. The results of the study are similar to the SA study on medical waste disposal, which indicated that most participants (61.8%) reported correct disposal practices.<sup>[7]</sup>

**Study limitations**

Challenges encountered in the course of this research included communication issues, time constraints, and confusion about anonymity. Some staff members, particularly nurses, were hesitant to reveal their age, which created discomfort in the data collection process. Additionally, several participants struggled with understanding the study's confidentiality measures. In particular, being asked to sign a consent form that required them to write their names led to concerns among staff that the study might no longer be anonymous.

Time constraints were another significant challenge. There was no designated time for staff to participate in the study – their schedules were busy, and some wards were understaffed. As a result, it was difficult to co-ordinate participation. Additionally, some nurses had limited experience and/or knowledge regarding waste disposal practices, which affected their ability to provide valuable insights. Miscommunication between the nursing director and ward managers also posed an obstacle. When our research team visited certain wards, some ward managers indicated that they had not been informed of the visit in advance, causing further misunderstandings and delays in the study process.

## Conclusion

The study findings indicate that, overall, healthcare workers at the study hospital had satisfactory knowledge and practices regarding the safe disposal of biomedical waste, which is crucial for preventing infections. However, some gaps remain in areas such as the proper segregation of waste, the handling of sharps, and the use of personal protective equipment. These gaps suggest the need for ongoing education and targeted training to address these specific areas. By providing this instruction, healthcare facilities can ensure more consistent adherence to proper disposal protocols, ultimately improving infection control and safety standards.

## Recommendations

There should be clear communication between top management and the ward managers to convey approval to conduct research in the wards. The hospital should implement training for personnel on proper waste disposal. The hospital should also provide staff with the necessary equipment to ensure proper waste disposal.

**Declaration.** The research for this study was done by the student team in partial fulfilment of the requirements for the BPharm degree at Sefako Makgatho Health Sciences University.

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**AI declaration.** This manuscript has utilised artificial intelligence (AI)-assisted technologies to paraphrase and enhance certain sections of the text. Specifically, OpenAI's ChatGPT was employed to rephrase content for improved clarity and readability. All AI-generated content has been thoroughly reviewed and edited by the authors to ensure accuracy and alignment with the manuscript's objectives. The authors take full responsibility for the final content of the manuscript.

**Author contributions.** DAM, MFM, INL and MKM, BPharm students,

contributed to the study conceptualisation, design, data collection and analysis. MPM and NLS contributed to the study as supervisors by guiding the students in conceptualisation of the study and preparation and reviewing of the manuscript.

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**Data availability statement.** The data sets generated and analysed during the current study are available from the corresponding author (MPM) upon reasonable request.

**Conflicts of interest.** None.

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