

Medical waste disposal at a hospital in Mpumalanga Province, South Africa: Implications for training of healthcare professionals

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Background. Healthcare professionals (HCPs) produce various types of waste in the course of rendering healthcare services. Each classification of waste must be disposed of according to the prescribed guidelines. Incorrect disposal of waste may pose a danger to employees, patients and the environment. HCPs must have adequate knowledge of the disposal of medical waste.

Objectives. To determine the knowledge and practices of HCPs with regard to medical waste disposal at a hospital in Mpumalanga Province, South Africa.

Methods. A quantitative cross-sectional research approach was used. The study respondents included nurses, medical doctors, dental health staff and allied health staff. Data were collected through self-administered questionnaires and analysed using IBM SPSS version 22.0.

Results. A high proportion of HCPs did not have adequate knowledge regarding the disposal of medical waste, but nevertheless disposed of medical waste appropriately. While the knowledge and practices of HCPs with regard to medical waste disposal were not associated with age, gender or years of experience, there was an association between professional category and knowledge and practices.

Conclusions. Disposal of medical waste is the responsibility of all HCPs. All categories of HCPs should receive regular training to improve their knowledge regarding disposal of medical waste and to minimise the risks associated with improper waste management. This will further increase compliance with the guidelines on disposal of medical waste.

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Nurses, medical doctors, and dental and allied health staff are healthcare professionals (HCPs) who generate various types of hazardous hospital waste when they provide healthcare services and when they conduct research in hospitals, clinics, blood banks and blood collection services, mortuary and postmortem centres, laboratories and research institutes.^[1,2] Hospital waste is classified as medical waste, chemical waste, radioactive waste, cytotoxic waste, pharmaceutical waste and general waste. The focus of this article is on medical waste, which includes sharps, laboratory waste, human tissue and cadavers used for research purposes. Each waste category must be disposed of correctly according to specific guidelines to protect HCPs, ward cleaners, laundry workers and patients from needlestick injuries and biological hazards.^[1,2] An important first step in the correct disposal of medical waste is the separation of waste at the point of generation, followed by its disposal into colour-coded containers. Medical waste in these containers can then be disposed of through incineration, sterilisation, chemical disinfection or burial in a secured landfill.^[3] Sharps, which include hypodermic needles, saws, pipettes, scalpels, broken glass and blades, are disposed of through incineration, chemical disinfection and microwaving. Laboratory waste, which includes body fluids, human tissue and cultures, can be disposed of through incineration or chemical disinfection. Human tissue, body parts, fetuses and cadavers must be disposed of through incineration.^[2] It is essential that all medical waste is separated out at the point of generation, appropriately treated and correctly disposed of.^[2] HCPs have a responsibility to protect the community and other workers by disposing of medical waste correctly.

Correct disposal of medical waste requires that HCPs have adequate knowledge of the various disposal methods. All HCPs in South Africa (SA) receive training on the correct disposal of medical waste at the medical, dental or nursing schools they attend in order

to qualify.^[4] Hospital management, as the employer of these HCPs, has a responsibility to provide employees with continuing training in correct disposal methods. HCPs also have a responsibility to attend training provided by their employers.^[5] Training should include knowledge of occupational hazards, management of exposure to blood and body fluids, correct medical waste disposal procedures, prevention of injury and diseases that could result from handling medical waste, and management of needlestick injuries.^[6] Studies indicate that a number of HCPs in countries such as Ghana, India, Pakistan, Malaysia and SA have inadequate knowledge of the categories of medical waste, correct waste disposal procedures for each category, and the legislation governing medical waste disposal in their countries.^[7,8]

Occupational health reports at a hospital in Mpumalanga Province, SA, showed an increase in the number of needlestick injuries among ward cleaners. Ward cleaners do not use needles and other sharps, so it was not expected that they would experience such injuries. Studies indicate that ward cleaners are injured by needles that HCPs have disposed of incorrectly.^[2,9,10]

Objective

To determine the knowledge and practices of HCPs regarding medical waste disposal at the study hospital, and the association between demographic factors and knowledge and practice of HCPs.

Methods

The study used a quantitative cross-sectional research approach. A sample of 178 HCPs was selected from a population of 319 employees through a stratified random sampling technique, using professional categories as strata. Data were collected by means of a self-administered questionnaire, which included completion instructions (Appendix 1).

The questionnaire was adapted from a study conducted in Yemen.^[11] It had the headings 'agree', 'disagree' and 'neutral'. Agreeing with a statement meant having adequate knowledge, disagreeing meant inadequate knowledge, and neutral meant that the respondent was unsure. Ethical approval was obtained from the University of Limpopo (ref. no. MREC/HS/277/2014: PG), and participants gave informed consent to participate in the study. The Mpumalanga provincial Department of Health and the management of the hospital gave permission for data collection at the hospital. Data were analysed using SPSS version 22.0 (IBM, USA), with the assistance of a statistician, into descriptive statistics such as frequencies. The χ^2 test was used to test associations between variables.

Results

Sociodemographic information

The sample consisted of 178 HCPs (150 nurses (84.3%), 9 medical doctors (5.1%), 3 dental staff (1.7%) and 16 allied health staff (9.0%)). The majority of the respondents (144, 80.9%) were females. Most respondents (68.5%) were aged ≥ 36 years, with only 2.2% being 21 - 25 years old. With regard to years of experience as HCPs, 24.2% of the respondents had 0 - 5 years' experience, 20.8% 6 - 10 years, 16.9% 11 - 15 years, 14.0% 16 - 20 years and 24.2% >20 years. HCPs with 0 - 5 years of experience and those with >20 years represented the majority of the respondents, while those with 16 - 20 years of experience made up the smallest group.

Knowledge and disposal practices

Table 1 indicates that 80 (44.9%) of the HCPs reported having inadequate knowledge of the correct disposal of medical waste, 84 (47.2%) reported having adequate knowledge, and 14 (7.9%) were not sure about the adequacy of their knowledge. Table 1 further indicates the percentage distribution of HCPs according to disposal practice, with 32.0% reporting incorrect disposal practices, 61.8% reporting correct practices and 6.2% being unsure about the correctness of their disposal practices.

Association between knowledge and medical waste disposal practices

Of the respondents, 19.7% reported having inadequate knowledge of disposal practices but nevertheless employed correct disposal practices; a higher proportion (22.5%) employed incorrect disposal practices and had inadequate knowledge of these practices. Nine percent of the respondents reported employing incorrect disposal practices despite having adequate knowledge of these practices, while a higher proportion (36.0%) reported having adequate knowledge of disposal practices and also employing correct disposal practices. There was an association between knowledge and practice with respect to medical waste disposal (χ^2 test, $p=0.000$) (Table 2).

Association between sociodemographic factors and knowledge and practice of medical waste disposal

There was an association between professional category and both knowledge about the disposal of medical waste (χ^2 test, $p=0.003$) and practice of HCPs (χ^2 test, $p=0.001$). The association between knowledge and practice and other variables was statistically insignificant (Table 1).

Discussion

There were more female than male HCPs in the study population, and more nurses than other HCPs participated in the study. This is similar to the population composition of HCPs in studies undertaken in other countries.^[11]

When the percentage of HCPs who reported having inadequate knowledge of waste disposal practices was added to the percentage of those who were not sure about the adequacy of their knowledge,

Table 1. Sociodemographic variables in relation to knowledge and practice regarding disposal of medical waste among HCPs (N=178)

Variable	n (%)	p-value
Gender		
Male	34 (19.1)	
Female	144 (80.9)	
Professional category		
Doctor	9 (5.1)	
Dentist	3 (1.7)	
Nurse	150 (84.3)	
Allied health worker	16 (9.0)	
Knowledge of HCPs		
Inadequate knowledge	80 (44.9)	
Not sure	14 (7.9)	
Adequate knowledge	84 (47.2)	
Practice of HCPs		
Correct practice	110 (61.8)	
Not sure	11 (6.2)	
Incorrect practice	57 (32.0)	
Gender and knowledge regarding correct disposal of medical waste		0.243
Males		
Inadequate knowledge	15 (8.4)	
Not sure	5 (2.8)	
Adequate knowledge	14 (7.9)	
Females		
Inadequate knowledge	65 (36.5)	
Not sure	9 (5.1)	
Adequate knowledge	70 (39.3)	
Gender and practice regarding disposal of medical waste		0.908
Males		
Inadequate knowledge	10 (5.6)	
Not sure	2 (1.1)	
Adequate knowledge	22 (12.4)	
Females		
Inadequate knowledge	48 (27.0)	
Not sure	8 (4.5)	
Adequate knowledge	88 (49.4)	
Age (years) and knowledge regarding disposal of medical waste		0.133
21 - 25		
Inadequate knowledge	4 (2.2)	
Not sure	0 (0.0)	
Adequate knowledge	0 (0.0)	
26 - 30		
Inadequate knowledge	8 (4.5)	
Not sure	3 (1.7)	
Adequate knowledge	8 (4.5)	

Continued ...

Table 1. (continued) Sociodemographic variables in relation to knowledge and practice regarding disposal of medical waste among HCPs (N=178)

Variable	n (%)	p-value
31 - 35		
Inadequate knowledge	15 (8.4)	
Not sure	0 (0.0)	
Adequate knowledge	18 (10.1)	
>36		
Inadequate knowledge	53 (29.8)	
Not sure	11 (6.2)	
Adequate knowledge	58 (32.6)	
Age (years) and practice regarding disposal of medical waste		0.139
21 - 25		
Incorrect practice	4 (2.2)	
Not sure	0 (0.0)	
Correct practice	0 (0.0)	
26 - 30		
Incorrect practice	8 (4.5)	
Not sure	1 (0.6)	
Correct practice	10 (5.6)	
31 - 35		
Incorrect practice	10 (5.6)	
Not sure	2 (1.1)	
Correct practice	21 (11.8)	
>36		
Incorrect practice	36 (20.2)	
Not sure	7 (3.9)	
Correct practice	79 (44.4)	
Professional category and knowledge regarding disposal of medical waste		0.003
Doctor		
Inadequate knowledge	7 (3.9)	
Not sure	0 (0.0)	
Adequate knowledge	2 (1.1)	
Dentist		
Inadequate knowledge	2 (1.1)	
Not sure	1 (0.6)	
Adequate knowledge	0 (0.0)	
Nurse		
Inadequate knowledge	58 (32.6)	
Not sure	12 (6.7)	
Adequate knowledge	80 (44.9)	
Allied health worker		
Inadequate knowledge	13 (7.3)	
Not sure	1 (0.6)	
Adequate knowledge	2 (1.1)	

Continued ...

Table 1. (continued) Sociodemographic variables in relation to knowledge and practice regarding disposal of medical waste among HCPs (N=178)

Variable	n (%)	p-value
Professional category and practice regarding disposal of medical waste		0.001
Doctor		
Incorrect practice	5 (2.8)	
Not sure	0 (0.0)	
Correct practice	4 (2.2)	
Dentist		
Incorrect practice	1 (0.6)	
Not sure	1 (0.6)	
Correct practice	1 (0.6)	
Nurse		
Incorrect practice	40 (22.5)	
Not sure	9 (5.1)	
Correct practice	101 (56.7)	
Allied health worker		
Incorrect practice	12 (6.7)	
Not sure	0 (0.0)	
Correct practice	4 (2.2)	
Years of experience and knowledge about disposal of medical waste		0.506
0 - 5		
Inadequate knowledge	23 (12.9)	
Not sure	3 (1.7)	
Adequate knowledge	17 (9.6)	
6 - 10		
Inadequate knowledge	14 (7.9)	
Not sure	3 (1.7)	
Adequate knowledge	20 (11.2)	
11 - 15		
Inadequate knowledge	12 (6.7)	
Not sure	0 (0.0)	
Adequate knowledge	18 (10.1)	
16 - 20		
Inadequate knowledge	11 (6.2)	
Not sure	3 (1.7)	
Adequate knowledge	11 (6.2)	
>21		
Inadequate knowledge	20 (11.2)	
Not sure	5 (2.8)	
Adequate knowledge	18 (10.1)	

Continued ...

the total percentage of HCPs who are assumed to have inadequate knowledge of correct waste disposal practices was higher than

the percentage who reported having adequate knowledge of these practices. The low proportion who reported adequate knowledge of correct disposal practices is worrying, as lack of knowledge of correct disposal methods may lead to incorrect disposal of medical waste. Studies to evaluate training on medical waste disposal among HCPs have indicated that training improved knowledge of correct disposal practices.^[12,13] Incorrectly disposed medical

Table 1. (continued) Sociodemographic variables in relation to knowledge and practice regarding disposal of medical waste among HCPs (N=178)

Variable	n (%)	p-value
Years of experience and practice regarding disposal of medical waste		0.873
0 - 5		
Incorrect practice	16 (9.0)	
Not sure	1 (0.6)	
Correct practice	26 (14.6)	
6 - 10		
Incorrect practice	11 (6.2)	
Not sure	1 (0.6)	
Correct practice	25 (14.0)	
11 - 15		
Incorrect practice	9 (5.1)	
Not sure	3 (1.7)	
Correct practice	18 (10.1)	
16 - 20		
Incorrect practice	7 (3.9)	
Not sure	2 (1.1)	
Correct practice	16 (9.0)	
>21		
Incorrect practice	15 (8.4)	
Not sure	3 (1.7)	
Correct practice	25 (14.0)	

Table 2. Association between knowledge and practice regarding disposal of medical waste

	Inadequate practice, n (%)	Not sure, n (%)	Correct practice, n (%)	p-value
Inadequate knowledge, n (%)	40 (22.5)	5 (2.8)	35 (19.7)	0.000
Not sure, n (%)	2 (1.1)	1 (0.6)	11 (6.2)	
Adequate knowledge, n (%)	16 (9.0)	4 (2.2)	64 (36.0)	

waste is a hazard to healthcare workers, patients, visitors and the environment.^[1,2,8,9] The results of this study are similar to the results of studies conducted in other countries and reveal a lack of adequate knowledge and awareness of medical waste disposal among HCPs.^[11] The results further show that a small proportion of HCPs were not sure of the adequacy of their knowledge of waste disposal techniques despite having been taught the correct techniques as part of their professional education and training, but continued to generate and dispose of medical waste in their day-to-day activities. It is expected that HCPs will possess the necessary knowledge to dispose of medical waste correctly.^[5]

The proportion of HCPs who reported that they disposed of medical waste correctly was higher than the proportion who did not. The results are similar to those of a 2008 SA study^[6] and a 2013 Indian study,^[11] which showed that doctors and nurses disposed of medical waste correctly. A study conducted in Ethiopia found that only 35.0% of HCPs disposed of medical waste correctly.^[14] Another

SA study conducted in the Free State Province^[15] found that 79% of HCPs disposed of medical waste incorrectly. The difference between the findings of this study and our study is huge, but the Free State study was conducted in all public hospitals in the province whereas ours was conducted in only one hospital.

The majority of HCPs at the hospital had adequate knowledge regarding disposal of medical waste and disposed of medical waste correctly. A small number were unsure about their knowledge and practices with respect to the disposal of medical waste. There was no association between knowledge and practice of waste disposal among HCPs and age, gender and years of experience, but there was an association between professional category and knowledge and practice of medical waste disposal.

Study limitations

Informal language was used in some of the questions in the questionnaire, and this could have caused information bias, as respondents had varying levels of understanding of English. Some of the questions were phrased in a manner biased towards the expected answer.

Conclusions

The results show that there is insufficient knowledge of disposal of medical waste among HCPs. Correct medical waste disposal practices were practised by more than half of the HCPs. Nurses comprised the highest proportion of professionals undertaking proper practices. This implies that there is a need to train other professional categories to ensure correct disposal of medical waste. The findings show that there was no association between knowledge and practice of waste disposal and age, gender or years of experience. There was an association between professional category and knowledge and practice of waste disposal, and also an association between actual practice of waste disposal and knowledge of the correct disposal techniques. Disposal of medical waste is the responsibility of all HCPs, and they are required to have knowledge of disposal techniques and to implement waste management guidelines. There is a need to improve the knowledge of HCPs with regard to waste disposal, particularly among doctors, allied health staff and dentists, as their practice scores were lower than those of nurses. This will further increase compliance with the correct disposal of medical waste.

Recommendations

It is recommended that hospital management explore the feasibility of training and supervision of all HCPs on the disposal of medical waste, considering available resources. Lack of resources, insufficient supervision and poor training were identified as causes of incorrect disposal of medical waste by HCPs.^[1]

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Appendix 1. Questionnaire

Section A: Demographic information

1. Gender

Male	1	Female	2
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2. Age, years

21 - 25	1	26 - 30	2	31 - 35	3	>35	4
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3. Professional category

Doctor	1	Dentist	2	Nurse	3	Allied health (specify)	4
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4. Years of experience

0 - 5	1	6 - 10	2	11 - 15	3	16 - 20	4	>20	5
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Section B: Knowledge

	Statement	Disagree = 1	Agree = 2	Neutral = 0
5	I know from policy that personal protective equipment is to be used routinely when handling medical waste.	1	2	0
6	I am aware of the regulation that placing medical waste in wrong bin is a high risk.	1	2	0
7	I am aware that there are waste bins for disposal of wastes as regulated	1	2	0
8	I know of policy documents regarding adequate disposal procedures of human tissue remains.	1	2	0
9	I read and understood that throwing human tissue remains in domestic waste is an adequate disposal procedure.	1	2	0
10	I read and understood that throwing expired blood units in domestic waste is an adequate disposal procedure.	1	2	0

11	I know from policy documents that it is necessary to sort medical waste at the point of generation.	1	2	0
12	Our policy document dictates that liquid waste must be disposed into the sewage without processing or treatment.	1	2	0
13	I consider used dressings, cotton and plasters as medical waste according medical waste classification.	1	2	0
14	I know that used cartons, paper and plastics are classified as medical waste	1	2	0
15	I am aware that improper waste disposal can lead to needlestick injuries.	1	2	0
16	Our policy document informs us that the colour code for disposal of human, biological and any object that has been in contact with body fluids is yellow, as per guidelines for waste management.	1	2	0
17	I know that the colour code for microbiological waste is red, as per guidelines for waste management.	1	2	0
18	I am aware that untreated medical waste can be stored for more than 48 hours in the temporary storage area, as per regulations.	1	2	0
19	I know from policy documents that any waste mixed with medical waste must be treated as medical waste.	1	2	0
20	I read and understood that improper waste disposal may lead to transmission of diseases.	1	2	0

Section C: Practice

	Statement	Disagree = 1	Agree = 2	Neutral = 0
21	Gloves used when handling medical waste.	1	2	0

22	Colour coding used for segregating medical waste.	1	2	0
23	Medical waste separated from general waste.	1	2	0
24	Medical waste segregated into infectious and non-infectious waste.	1	2	0
25	Special plastic bags used once for collecting medical waste.	1	2	0
26	Liquid waste disposed in bags that prevent leakage.	1	2	0
27	Blood waste disposed in separate bags that prevent leakage.	1	2	0
28	Human tissue remains disposed in separate bags that prevent leakage.	1	2	0
29	Liquid wastes collected together with other wastes.	1	2	0
30	Liquid waste disposed directly into sewage system without any processing (dilution and/or sterilisation).	1	2	0
31	Liquid waste disposed into sewage system after processing.	1	2	0
32	Used needles not recapped.	1	2	0
33	Used needles discarded immediately after use.	1	2	0
34	Used needles discarded in a designated sharps container.	1	2	0
35	Sharps containers are replaced when they are $\frac{3}{4}$ full.	1	2	0
36	Waste containers labelled with biohazard stickers.	1	2	0
37	Needlestick injury reported to the occupational health nurse.	1	2	0
38	A temporary waste storage area available in the hospital.	1	2	0
39	Personal protective equipment available.	1	2	0
40	Waste monitoring inspections conducted on monthly basis.	1	2	0