Predictors of Compliance to Biomedical Waste Segregation among Workers in Health Facilities in Jinja District, Uganda

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Abstract

Background: Compliance with biomedical waste segregation among healthcare workers, particularly in developing economies, is a major challenge. One of the main issues is establishing the predictors of compliance as a step toward addressing this challenge. Therefore, this study focused on establishing the predictors of compliance to biomedical waste segregation among health workers in health facilities, focusing on the Jinja district in Uganda.

Method: This study utilized a cross-sectional study design that employed quantitative and qualitative methods using a questionnaire and key informant interview approaches.

Results: The results showed that most (54.7%) health workers were not compliant with biomedical waste segregation. Additionally, the study found that gender, education, cadre, and experience were not significantly associated with compliance with biomedical waste segregation ($p > 0.05$). It also revealed that health facility ownership and support supervision were significantly associated with compliance with biomedical waste segregation among health workers ($p = 0.001$, $p = 0.000$).

Conclusion: Health workers in the Jinja District do not generally comply with biomedical waste segregation. There is a need for the health system to increase efforts to support supervision and funding to reduce the effects of poor biomedical waste segregation.

Keywords: Biomedical waste, segregation, health care, waste management, Uganda

Introduction

In 2017, the World Health Organization (WHO, 2017) reported that medical waste management has become a major global health challenge, placing health workers at risk while working in health facilities. This indicates that there are countless inefficiencies in compliance with biomedical waste management. In Southeast Asian countries, for example, compliance with biomedical segregation is very low in Indonesia, Myanmar, Bhutan, and India, where there is poor segregation and compliance (WHO, 2017).

In sub-Saharan Africa, Stringer *et al.* (2010) reported that, due to inadequate funds, there is very little support given to health, especially medical waste management. Often, the adoption of an appropriate system for biomedical waste segregation has been limited.

In two East African countries, Kenya and Tanzania, the Ministry of Health (MoH) reported 55% and

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42.6% compliance with waste segregation in health facilities, respectively (MoH, Tanzania 2018; Maina, 2018). In Uganda, the Ministry of Health reported in 2013 that waste segregation in health facilities was low. The Making Medical Injections Safer (MMIS) indicated that 25% of health facilities had sharp waste littering facilities (MoH, Uganda 2013).

In a study conducted at the Bwindi Community Hospital in western Uganda, Kwikiriza *et al.* (2019) reported poor personal and/or departmental practices in waste management, resulting in incorrect segregation of clinical waste at the source (> 93% of time). In Jinja District, the Eastern Region of Uganda, 90% of health facilities were found to mix biomedical waste, as observed during support supervision by the district health team (Jinja District, 2019). This shows limited compliance with appropriate biomedical segregation. The report further indicated that 45.2% of supervised health facilities lacked appropriate coded bins, bin liners, and safety boxes. In addition, 29% had no segregation guidelines and 32.3% did not have in-service training in health care waste management. This is similar to the situation in the Palisa District in Uganda (Akulume & Kiwanuka. 2016).

Segregation has been defined as separating waste and placing it in different color-coded bins, preferably where they are generated (Federal MoH Ethiopia, 2012; MoH Uganda, 2013a; Rao *et al.,* 2004). In terms of the significance of segregation, Manasi et al. (2014) argued that waste segregation reduces this challenge and the related risks of infecting health facility staff and patients.

In Uganda, the MoH recommends the following predictors of biomedical waste segregation: presence of a committee/focal person, sufficient resources, segregation requirements, guidelines/job aides, training, and procurement issues (MoH Uganda, 2013a). Therefore, the present study aimed to investigate the predictors of compliance with biomedical waste segregation among health workers in health facilities in the Jinja District. The specific objectives were:

1. To establish the level of compliance with biomedical waste segregation among health workers in health facilities.
2. To assess the individual and health system predictors associated with biomedical waste segregation among health workers.
3. To examine the relationship between predictors and compliance with biomedical waste segregation in health facilities.

The literature reviewed indicates how individual predictors such as gender, age, educational level, and cardre are associated with compliance with biomedical waste segregation (Kumar *et al.,* 2013; Mesfin. *et al.,* 2013; Njiru *et al.,* 2013; Hakim *et al.,* 2014; Habeeb & Ahmad, 2015; Haifete *et al.,* 2016; Ocean Conservancy, 2019;

Wafula *et al.,* 2019; Sahiledengle, 2019).

Health system factors, such as health facility level, health facility ownership, planning for waste segregation, procurement of required waste segregation tools, training of health workers in waste segregation, and supervision of health workers, influence compliance with biomedical waste segregation among health workers (Patil & Shekdar*,* 2001; Basel Convention Secretariat & WHO, 2005; WHO, 2004; Gupta & Boojh*,* 2006; Athavale & Dhumale, 2010; Republic of Namibia, 2011; Nkonge *et al.,* 2012; Sanjeev, *et al.,* 2014; Mesfin, *et al.,* 2014; Oli. *et al.,* 2016; Towett, 2015; Mwakanyamale, 2017; WHO 2017; Maina 2018; MoH Tanzania, 2018; Kwikiriza, *et al.,* 2019). Differences exist owing to research conducted in different contexts. Hence, there is a need to establish health workers' behavior and health system predictors in this district to explain why noncompliance prevails.

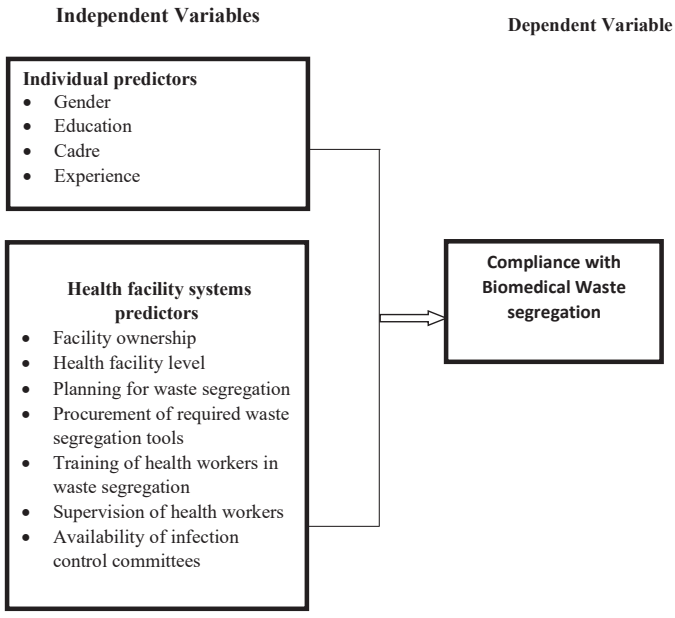
Conceptual Framework

This study relied on two theories: the Socio-Ecological Model and Health Belief Model. Both models address health system predictors related to policy, institutional, interpersonal, and individual factors (Glanz *et al*., 2005; Whitehead & McNiff, 2006).

The conceptual framework (Figure 1) developed from the two models illustrates the hypothesized relationships between the independent and dependent variables.

Figure 1

Conceptual Frame work



Methods

This study utilized a cross-sectional design that employed both quantitative and qualitative research approaches. A self-administered questionnaire was used to collect quantitative data. In addition, key informant interviews were used to collect qualitative data to confirm and explain the information derived from quantitative data.

The study was conducted in seven sub-counties comprising the Jinja district in the eastern central region of Uganda. These are Butagaya, Kakira, Busede, Buyengo Town Council, Buwenge Rural, Namagera Town Council, and the Buwenge Town Council. Jinja district has a population of 237,006 (Uganda Bureau of Statistics, 2016). The district has 31 government health facilities: three hospitals, one health center IVs, seven health center IIIs, and 20 health center IIs.

Of the 31 health facilities, 11 were purposively selected because they had fully established departments that handle biomedical waste on a daily basis. In the selected health facilities, 213 health workers were targeted, including medical officers, clinical officers, nurses, midwives, and laboratory technicians who are at the forefront of segregating biomedical waste. The selection criteria included all health workers working in the outpatient department, maternity, laboratory, wards, and dispensing facilities. Those excluded were all staff on leave and internships (Table 1).

Table 1

Target Population Distribution by Cadre

Study population	Number of health workers by cadre					
	Doctors	Clinical officers	Nurses	Midwives	Lab. tech	Total
Numbers	11	14	115	52	21	213

Source: District Health Office, Jinja (2018)

Sample Size

The sample size of the 213 target population was calculated using Slovin's formula, which was determined to be 139. Purposive sampling was used to select all three 3 hospitals and one health center (IV). Simple random sampling was used to select 6 health center IIIs out of a total of 7.

Study participants from each cadre level were obtained using stratified random sampling. Propor-

tionate sampling was then performed using the sample size for each cadre to select health workers from each cadre who participated in the study. Health workers in each stratum were selected using random sampling. Key informants were purposively selected. Using the key informant interview guide (KIIG), they provided relevant information for each factor under review. All health workers who met the inclusion criteria were recruited until the required number of 139 health workers was obtained (Table 2).

Table 2

Sample Size Per Cadre

Study population	**Number of health workers**					
	Doctors	Clinical officers	Nurses	Midwives	Lab. tech	Total
Target population	11	14	115	52	21	213
Sample	07	09	75	34	14	139

Ethical Considerations

This study was approved by The AIDS Support Organization (TASO) Research Ethics Committee (REC) in Mulago, Kampala, Uganda. Before distributing the questionnaires, it was explained to the respondents that the data were collected for research and academic purposes and that they were free to opt out of the research at any point.

Data Collection and Analysis

This study used two data-collection approaches and two research instruments. The survey used a self-administered questionnaire comprising of three sections: individual predictors, health system predictors, and compliance with biomedical segregation. Interviews were conducted using the KIIG and targeted officers in charge of health facilities and administrators.

The collected data were analyzed using the SPSS® (Statistical Package for the Social Sciences). Statistical analyses such as percentages, Pearson's chi-square test, logistic linear regression, and multivariate analyses were conducted. In the bivariate analysis, predictors with p <0.05 were considered significant. Such factors were subjected to multinomial regression to derive Odds Ratios (OR) along with the corresponding 95% confidence intervals (CIs) and p <0.05. Thematic analysis was also conducted to draw meaning from the interviews.

Results

There was a 100% response rate from 139 health workers in the different health facilities who fulfilled the selection criteria and consented to participate in the study.

Compliance with Biomedical Waste Segregation

With regard to compliance with biomedical waste segregation, the results showed that the majority (54.7%) of health workers were not compliant. The compliance level of 45.3% was slightly higher than the national average of 42%. Related to this is the fact that 34.5% of the health workers reported that infection control committees were not functional in their institutions, among other challenges, as reported by a key informant (KI4).

> "*The majority of the health workers adhere to color-coded bin segregation practice, but the challenge lies with non-availability of bin liners on a regular basis*" *(KI 4)*

Individual Predictors Associated with Biomedical Waste Segregation

The individual profiles of the health workers included gender, cardre, education, and work experience. With regard to gender, the results showed that the majority (77.7%) of the respondents who participated in the study were females, and the rest were males. Regarding education levels, the findings showed that the majority (58.3%) of the health workers had certificates as the highest level of education, 33.1% had diplomas, and only 8.6% had a degree level.

On the level of cardreship, the results show that more than half (54.0%) of the respondents were nurses, followed by midwives (23.0%), and laboratory assistants (10.8%). However, only 7.9% and 4.3% were clinical officers and doctors, respectively.

With regard to work experience, the results indicate that the majority (79.9%) of the respondents had work experience of five years and above, followed by those who had two years (7.2%) and those who had three years' experience (5.8%).

Health Systems Factors Associated with Biomedical Waste Segregation

The results showed that 41.0% of the respondents were from HC IIIs, 36.7% were from hospitals, and 22.3% were from HC IVs. This implies that HC Level III facilities constitute the majority of health workers who participated in the research and constituted the highest non-compliance to biomedical waste segregation staff.

Most respondents (87.1%) were from government-owned facilities and only 12.9% were from private facilities. The results further showed that most respondents (61.9 %) indicated that health facilities plan for biomedical waste segregation. This is attributed to MoH Uganda and its partners' emphasis on providing quality healthcare.

Regarding the procurement of necessary waste segregation tools, the results showed that the majority (69.8%) of the respondents reported that health facilities procured biomedical waste segregation tools. However, only 66.9% indicated that the procurement was timely. Furthermore, most respondents (63.3%) reported that they were not trained in biomedical waste segregation. However, regarding the issue of supervision of health workers, the majority (78.4%) of the respondents indicated that they had been supervised at least once in the last six months. Of those supervised, 63.3% agreed that biomedical waste segregation was covered during support supervision, and only 10.1% indicated that waste segregation was not covered.

Finally, regarding the availability and functionality of infection control committees, the results showed that the majority (94.2%) of health workers reported that these committees are available and are functioning. Among those who reported having these committees at their facilities, the majority (59.7%) said that the committees were functional.

Predictors of Biomedical Waste Segregation among Health Workers

To establish which individual and health system predictors are associated with biomedical waste segregation among health workers, Pearson Chi-square (X^2) tests were conducted, and the results are shown in Tables 3 and 4. The variables that showed a significant association with compliance with biomedical waste segregation were subjected to inferential analysis using binary logistic linear regression to obtain crude Odds Ratios, p-values, and Confidence Intervals (CI), as presented in Table 5. To obtain the final model of predictors of compliance with biomedical waste segregation, significant variables after bivariate linear regression were further subjected to binary logistic linear multivariate analysis to generate Adjusted Odds Ratios (AOR), p-values, and corresponding 95% CI, as illustrated in Table 6. Both crude and adjusted odds ratios were used to identify the predictors of compliance with biomedical waste segregation among health workers.

Individual Predictors Association with Biomedical Waste Segregation

The results in Table 3 show no significant association between gender, education, cadre, and experience and compliance with biomedical waste segregation, as the *p*-values were > 0.05. This was further confirmed by a key informant (KI1) who reported the following.

> *"There is no big difference between health workers who are males or females in segregating wastes when they are providing a service as long as they have been trained, they will offer a service according to the knowledge and skills not according to being a male or a female."*

Table 3

Individual Predictors Associated with Compliance to Biomedical Waste Segregation in Health Facilities

Variable	Compliance status		X^2	Df	p-value
	Not compliant	Compliant			
Gender of Health Worker					
Male	14(45.2)	17(54.8)	1.458	1	0.227
Female	62(57.4)	46(42.8)			
Education level					
Cert	48(59.3)	33(40.7)	1.633	2	0.435
DIP	22(47.8)	24(52.2)			
Degree	6(50.0)	6(50.0)			
Cardre (type of Health worker)					
Nurses	45(60.0)	30(40.0)	1.863	1	0.172
Others	31(48.4)	33(51.6)			
Work Experience					
1-4 Years		13(46.4)	0.017	1	0.895
5 and above	61(55.0)	50(45.0)			

Health System Predictors Associated to Biomedical Waste Segregation

The results in Table 4 reveal that the following health system predictors: planning, procurement, and availability of infection control committees were not significantly associated with compliance to biomedical waste segregation among health workers in this district (p>0.05).

Table 4

Health System Predictors Associated with Compliance to Biomedical Waste Segregation in Health Facilities

Variable	Compliance status		X^2	df	p-value
	Not compliant	Compliant			
Facility Ownership					
Government	74(61.2)	47(38.8)	15.836	1	0.000*
Private	2(11.1)	16(88.9)			
Health facility level					
HCIII	25(43.9)	32(56.1)	9.224	2	0.010*
HCIV	24(77.4)	7(22.6)			
Hospital	27(52.7)	24(47.1)			
Planning for waste segregation					
Yes	42(48.8)	44(51.2)	3.103	1	0.078
No	34(64.2)	19(35.8)			
Procurement					
Yes	48(49.5)	49(50.5)	3.492	1	0.062
No	28(66.7)	14(33.3)			
Training					
Yes	26(51.0)	25(49.0)	0.444	1	0.505
No	50(56.8)	38(43.2)			
Nature of training					
CME	4(26.7)	11(73.3)	15.711	2	0.000*
On job training	21(75.0)	7(25.0)			
Workshop	1(11.1)	8(88.9)			
Support Supervision					
Yes	69(63.3)	40(36.7)	15.166	1	0.000*
No	7(23.3)	23(76.7)			
Availability of inf. control committee					
Yes	73(55.7)	58(44.3)	1.011	1	0.315
No	3(37.5)	5(62.5)			

*p-value < 0.0

However, Table 4 shows a significant relationship between the following health system factors: health facility ownership, health facility level, nature of training, and support supervision in compliance with biomedical waste segregation ($p< 0.05$).

Predictors to Compliance to Biomedical Waste Segregation among Health Workers

The variables that showed significant association in the Chi square (X^2) tests above (Tables 3 and 4) were subjected to logistic linear regression to obtain Crude Odds Ratios (COR) and corresponding 95% confidence intervals (CI). The results are presented in Table 5.

Table 5

Crude Odds Ratios for Predictors that were significantly associated with Biomedical Waste Segregation in the Chi Square (X^2) Analysis

Variable	Compliance		COR 95% CI	p-value
	Not Compliant	Compliant		
Facility Ownership				
Government	74(61.2)	47(38.8)	12.596[2.69-57.289]	0.001
Private	2(11.1)	16(88.9)		
Health facility level				
HCIII	25(43.9)	32(56.1)	0.820[0.560-1.201]	0.08
HCIV	24(77.4)	7(22.6)		
Hospital	27(52.7)	24(47.1)		
Nature of training				
CME	4(26.7)	11(73.3)	1.000[0.44-2.252]	1.000
On job training	21(75.0)	7(25.0)		
Workshop	1(11.1)	8(88.9)		
Support supervision				
Yes	69(63.3)	40(36.7)	5.668[2.233-14.385	0.000
No	7(23.3)	23(76.7)		

The results in Table 5 show that based on the logistic linear regression analysis, only health facility ownership and support supervision were found to be significantly associated with compliance with biomedical waste segregation among health workers. These were then further subjected to multivariate analysis to obtain an adjusted odds ratio (AOR) and Confidence Interval (CI) of 95%.

The results of the multivariate analysis are presented in Table 6. According to these results, after controlling for predictors in the model, health facility ownership was significantly associated with compliance with biomedical waste segregation among health workers in both bivariate and multivariate logistic analyses [COR=12.596, 95% CI= [2.691-57.289], and AOR=13.865, 95% CI= [2.934-65.511], respectively).

Table 6

Predictors Associated with Compliance to Biomedical Waste Segregation among Health Workers

Variable	Compliance		COR (CI; 95%)	AOR (CI; 95%)
	Not compliant	Compliant		
Facility Ownership				
Government	74(61.2)	47(38.8)	**12.596[2.691-57.289]**	**13.865[2.934-65.511]**
Private	2(11.1)	16(88.9)	1	
Gender				
Male	14(45.2)	17(54.8)	0.611[0.274-1.365]	0.675[0.261-1.746]
Female	62(57.4)	46(42.8)	1	
Support supervision				
Yes	69(63.3)	40(36.7)	**5.668[2.233-14.385]**	**6.097[2.307-16.113]**
No	7(23.3)	23(76.7)	1	
Level of education				
Cert	48(59.3)	33(40.7)	0.688[0.204-2.318]	1.378[0.303-6.261]
DIP	22(47.8)	24(52.2)	1.091[0.306-3.888]	1.530[0.588-3.982]
Degree	6(50.0)	6(50.0)	1	

Predictors to Compliance to Biomedical Waste Segregation Health Facility Ownership

The findings further suggest that the odds of compliance to biomedical waste segregation among health workers in government health workers in Jinja District was 14 times higher than that of health workers in private health facilities. This could be attributed to the regular funding available and support supervision of government facilities, as confirmed by a key informant (KI 3):

"The funds for procuring waste segregation tools are available at the beginning of a financial year and procurement plans are made timely" (KI 3). In private facilities, another Key Informant reported the following.

"Funding depends on the clients making payments and at times District Health Officers supply safety boxes during support supervision of immunization services" (KI 9).

Support supervision was found to be statistically significant (Table 6) after multivariate analysis with COR= 5.668, 95% CI= [2.233-14.385] and AOR = 6.097, 95% CI= [2.307-16.113]. This implies that the odds of compliance with biomedical waste segregation among health workers supervised on health care waste management was six

times higher than those not supervised. This was further supported by key informant reports (KI 6):

> *"Support supervision improves compliance to health care services including waste segregation and supervisors guide the frontline health workers on how to sort wastes" (KI 6).*

Discussion

A 54.7% level of compliance with biomedical waste segregation, while being better than the national average of 42%, would even be better if there were adequate support supervision by the infection control committees and if planning and training had been adequately performed. This is supported by the fact that 34.5% of the health workers reported that infection control committees were not functional, indicating that their supervisory role, policy formulation, and taking action on biomedical waste segregation challenges were ineffective.

This finding corroborates the WHO (2017) reports in Indonesia, Myanmar, Bhutan, and India. However, in these countries, segregation practices are much higher than the findings of this study. This could be attributed to the difference in social demographics, level of supervision, planning, training, and procurement procedures, as confirmed by KI 4.

The large (77%) percentage of female respondents among the cadres may be due to the fact that many of the health workers in Jinja District especially those in the nursing section is dominated by females (District Health Office, Jinja Human Resource Records 2018). The number of males and females depends on the number of workers in the facility; hence, it differs among researchers (Habeeb & Ahmad, 2015; Kiwanuka & Masaba, 2018; Wafula *et al.,* 2019; Sahiledengle, 2019). Regarding education level, the majority (58.3%) of the health workers had certificates as the highest level of education. This educational level is relatively low compared to other studies undertaken by Ramesh *et al.* (2013), who reported that more than 42% had graduate and postgraduate qualifications. With most (79.9%) workers having over five years of work experience, it is an important indicator that once trained, they will stay to implement what they have learned.

The results show that 41% of the respondents were from HC IIIs, which is significant in planning to reduce non-compliance because they can be specifically targeted. However, this noncompliance in lower-level health facilities could be due to inadequate supervision (Kiwanuka & Masaba, 2018). Most respondents (87.1%) were from government-owned facilities. This is important for the ease of having a target to improve supervision. Oli et al. (2015) argued that once there is strict supervision in government facilities, it is easier to do so in private facilities.

The majority (61.9%) of respondents indicated that health facilities plan for biomedical waste segregation. Thus, focusing on planning,

monitoring, and providing adequate resources would improve waste segregation (Patil & Shekdar, 2001; Mesfin, 2013; Mwakanyamale, 2017). About 69.8% of the respondents reported that procurement of the necessary waste segregation tools was being undertaken; however, another 66.9% reported that this was not done in a timely manner. This is in disagreement with the findings of Kwikiriza (2019) who earlier reported that in western Uganda the respondents said "Colored bin liners were often not available to order and so were not supplied consistently to the hospital wards" and that "The absence of bin liners initiates non-compliance to health care waste segregation, and it indicates a gap in procurement".

The 63.3% report of training in biomedical waste segregation was relatively low, and other researchers have even recorded much lower levels (Mesfin *et al.,* 2013). The researchers agree with Maina (2018), who recommended that the training of staff in healthcare waste management is effective in influencing the practice of waste segregation in health facilities. Regarding the issue of health workers' supervision, the majority (78.4%) of respondents indicated that they had been supervised in the last six months. This practice is within the recommendations of the WHO (WHO, 2020). Of those supervised, 63.3% agreed that biomedical waste segregation was covered during supervision. While the majority (94.2%) of respondents reported the existence of these supervisory committees, only 59.7% indicated that they were functioning. This means that some committees do not deliver on their supervisory and monitoring compliance.

The analysis results (Table 3) clearly show that in this study, gender, education, cadre, and experience are not predictors of compliance with biomedical waste segregation. This was further confirmed by key informant KI1. Moreover, the following health system predictors such as planning, procurement, and availability of infection control committees are not significantly associated with compliance. Conversely, health facility ownership, health facility level, nature of training, and support supervision are significantly associated with compliance. Further multivariate analysis also showed that facility ownership was the most significant factor affecting compliance. Government-owned facilities are 14 times more compliant than private ones. This finding is consistent with that of Oli *et al.* (2016) in Nigeria, which revealed that government participants were 1.7 times more likely to practice waste segregation at the point of generation in their day-to-day work. However, the results of the present study contradict the findings of Akulume & Kiwanuka (2016), who found a negative correlation between healthcare waste segregation behavior and facility ownership. This

discrepancy could be attributed to differences in methodology.

The supervision factor was also found to be significant after multivariate analysis. This is common among government facilities, as reported by the key informant KI 6. This finding supports the recommendations of Wafula *et al*. (2019), who suggested that continuous supervision is important for promoting proper healthcare waste practices among health workers. This could be attributed to continuous reminder and action plans drawn during supervision to address the gaps as expressed by a key informant KI 6)

Conclusion and Recommendations

Health workers in the Jinja district do not generally comply with biomedical waste segregation. There is a need for the health system to increase efforts to support supervision and funding to reduce the effects of poor biomedical waste segregation. It is recommended that the MoH in Uganda should maintain and strengthen regular support supervision of government health facilities, including privately owned healthcare establishments, and timely purchase of waste segregation equipment.

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