



ANALYSIS OF HEALTHCARE WORKER COMPLIANCE WITH SOLID MEDICAL WASTE MANAGEMENT IN THE INPATIENT

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ABSTRACT

Substandard management of solid medical waste can increase the risk of infections, workplace accidents, and environmental pollution. Healthcare worker compliance is a crucial factor in ensuring the safety of medical waste management in hospitals. This study aimed to analyze factors associated with healthcare worker compliance regarding solid medical waste management in the Inpatient Unit of RSUP Dr. Mohammad Hoesin Palembang. An observational analytic study design with a cross-sectional approach was employed. The study sample consisted of 139 healthcare workers. Data were collected using questionnaires and observation sheets, then analyzed via univariate, bivariate (Chi-square test), and multivariate (multiple logistic regression) methods. The results showed that 104 respondents (74.8%) were compliant, while 35 respondents (25.2%) were non-compliant regarding solid medical waste management. Variables significantly associated with compliance were attitude ($p=0.016$; $OR=2.796$), facilities and infrastructure ($p=0.006$; $OR=3.223$), training ($p=0.007$; $OR=3.140$), Standard Operating Procedures (SOPs) ($p=0.003$; $OR=8.417$), and supervision ($p=0.006$; $OR=3.326$). Age, education, knowledge, and tenure were not significantly associated with compliance. Logistic regression results indicated that facilities and infrastructure ($p=0.046$; $Exp(B)=2.428$; 95% CI 1.017–5.795) and SOPs ($p=0.002$; $Exp(B)=11.628$; 95% CI 2.421–55.848) were independently associated with compliance. SOPs were the most dominant factor. The model explained 26.6% of the variation in compliance based on the Nagelkerke R-Square value. It is concluded that healthcare workers' compliance with solid medical waste management is primarily influenced by the availability of Standard Operating Procedures (SOPs) and facilities. Hospitals need to ensure that SOPs are available and implemented in every unit, equip facilities according to standards, conduct periodic training, and enhance supervision and evaluation.

Keywords: compliance; facilities; healthcare workers; solid medical waste; SOPs

INTRODUCTION

Hospitals are healthcare facilities that generate medical waste through various inpatient, outpatient, and emergency care activities. Medical waste is classified as Hazardous and Toxic Material (B3) waste, the management of which is regulated by the Regulation of the Minister of Health of the Republic of Indonesia Number 2 of 2023 and Government Regulation Number 22 of 2021. Although B3 waste healthcare facility waste accounts for only about 10–20% of the total waste generated, it poses a high risk of causing injury, disease transmission, and environmental pollution if not managed according to standards (Usnaini et al., 2025).

Solid medical waste management encompasses segregation, containment, collection, transportation, storage, and disposal. Improper segregation can lead to the mixing of infectious waste and sharps with domestic waste, thereby increasing the risk of occupational accidents and infections for healthcare workers, cleaning staff, waste management personnel, and the general public. Nurses and healthcare workers are the group most frequently in contact with medical waste; therefore, adherence to standard operating procedures is essential (Huda, 2020; Arfan et al., 2023).

Staff compliance with medical waste management practices is influenced by various factors, including knowledge, attitudes, length of service, availability of facilities and infrastructure, training,

standard operating procedures, and supervision. While adequate knowledge and positive attitudes can reduce errors in waste segregation and containment, actual implementation still requires continuous training and supervision (Melia & Yulianti, 2024; Arikhman et al., 2025). As a Type A hospital and a national referral center, RSUP Dr. Mohammad Hoesin Palembang generates approximately 150 kg of solid medical waste daily. Preliminary study findings revealed that medical waste—such as syringes, IV bottles, and IV tubing—was still being mixed with domestic waste at temporary storage sites. Throughout 2025, an average of 64 cases of non-compliance were recorded monthly, with a peak of 95 cases in September. These conditions indicate that the implementation of medical waste management does not yet fully align with established policies and procedures. Given these issues, this study aims to analyze healthcare workers' compliance regarding solid medical waste management in the Inpatient Unit of RSUP Dr. Mohammad Hoesin Palembang. The findings are expected to serve as a basis for formulating recommendations to improve staff compliance and the quality of solid medical waste management at the hospital.

METHOD

This study employed an analytical observational design with a cross-sectional approach to analyze factors associated with healthcare workers' compliance regarding solid medical waste management. The study was conducted at the Inpatient Unit of Dr. Mohammad Hoesin General Hospital, Palembang, in 2026. The study population consisted of all healthcare workers employed in the Inpatient Unit who were involved in the initial management of solid medical waste. The sample comprised 139 respondents selected using proportional random sampling based on the number of staff in each inpatient ward. Inclusion criteria covered healthcare workers who had been employed for at least three months, were directly involved in patient care and waste management, and were willing to participate as respondents. Staff members who were on leave, on sick leave, or absent during data collection were excluded from the study. The dependent variable is compliance with solid medical waste management, categorized as compliant or non-compliant. Independent variables include age, education, knowledge, attitude, tenure, facilities and infrastructure, training, availability of standard operating procedures (SOPs), and supervision. Primary data were obtained through structured questionnaires and direct observation. Questionnaires were used to assess respondent characteristics, knowledge, attitudes, training, SOPs, supervision, and compliance. Observation checklists were used to evaluate the availability of facilities and infrastructure, as well as practices regarding waste segregation, containment, use of safety boxes, labeling, use of personal protective equipment (PPE), and medical waste transfer. Secondary data were obtained from sanitation unit reports, human resources records, SOP documents, training data, and medical waste management supervision records.

Data processing involved editing, coding, entry, cleaning, and tabulation. Univariate analysis was performed to describe the frequency distribution and percentage of each variable. Bivariate analysis utilized the Chi-square or Fisher's exact test to determine the relationship between independent variables and compliance. The strength of the association was expressed using odds ratios and 95% confidence intervals, with a significance level of $p < 0.05$. Variables with p -values < 0.25 in the bivariate selection were included in the multiple logistic regression analysis using the backward elimination method. The results of the multivariate analysis are presented as regression coefficients, p -values, adjusted odds ratios, and 95% confidence intervals. The variable with the highest significant adjusted odds ratio was identified as the dominant factor. The model's ability to explain adherence was assessed using Nagelkerke R-square and Cox & Snell R-square. The probability of adherence was calculated based on the final logistic regression model using the equation

$$P = \frac{1}{(1 + e^{-y})}$$

where P is the probability of liver dysfunction, e is the exponential constant (approximately 2.718), and y is a linear combination of predictor factors, expressed as:

$$y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \dots + \beta_n X_n$$

In the equation, β_0 represents the constant (intercept), and β_i is the regression coefficient for each independent variable (X_i). A positive β value indicates that the variable increases the likelihood of compliance, whereas a negative value indicates a protective effect.

RESULTS AND DISCUSSION

Analysis of factors associated with compliance in solid medical waste management

Table 1.

Analysis results of factors associated with compliance in solid medical waste management

Variable	Category	Not Compliant	Compliant	Total	P Value	OR CI 95%
Age	> 40 tahun	7	24	31	0.886	0.833 0.324-2.145
		22.6%	77.4%	100.0%		
	< 40 tahun	28	80	108		
Education	D III	8	24	32	1.000	0.988 0.397-2.457
		25.0%	75.0%	100.0%		
	S1/Profesi/S2	27	80	107		
Knowledge	Poor	4	7	11	0.468	1.788 0.491-6.517
		36.4%	63.6%	100.0%		
	Good	31	97	128		
Attitude	Negative	19	31	50	0.016	2.796 1.273-6.141
		38.0%	62.0%	100.0%		
	Positif	16	73	89		
Tenure	< 5 years	16	45	61	0.956	1.104 0.511-2.384
		26.2%	73.8%	100.0%		
	> 5 years	19	59	78		
Facilities & infrastrucuture	Non standard	19	28	47	0.006	3.223 1.457-7.129
		40.4%	59.6%	100.0%		
	Standard	16	76	92		
Training	None	20	31	51	0.007	3.140 1.424-6.921
		39.2%	60.8%	100.0%		
	Provided	15	73	88		
SOP	None	7	3	10	0.003	8.417 2.043-34.675
		70.0%	30.0%	100.0%		
	Provided	28	101	129		
Supervision	Poor	17	23	40	0.006	3.326 1.482-7.466
		42.5%	57.5%	100.0%		
	Good	18	81	99		
		18.2%	81.8%	100.0%		

The analysis results indicate that age, education, knowledge, and length of service are not significantly associated with compliance in solid medical waste management ($p > 0.05$). Meanwhile, attitude is significantly associated with compliance ($p=0.016$; $OR=2.796$; 95% CI 1.273–6.141); staff with a negative attitude are 2.796 times more likely to be non-compliant than those with a positive attitude. Facilities and infrastructure are also significantly associated with compliance ($p=0.006$; $OR=3.223$; 95% CI 1.457–7.129), meaning staff working with substandard facilities are 3.223 times more likely to be non-compliant. Training is significantly associated with compliance ($p=0.007$; $OR=3.140$; 95% CI 1.424–6.921); staff who have never undergone training are 3.140 times more likely to be non-compliant. The availability of Standard Operating Procedures (SOPs) is also

significantly associated with compliance ($p=0.003$; $OR=8.417$; 95% CI 2.043–34.675), where staff working without SOPs are 8.417 times more likely to be non-compliant. Furthermore, supervision is significantly associated with compliance ($p=0.006$; $OR=3.326$; 95% CI 1.482–7.466); staff receiving poor supervision are 3.326 times more likely to be non-compliant. Thus, the variables associated with compliance are attitude, facilities and infrastructure, training, SOPs, and supervision, with SOPs being the factor with the highest OR value in the bivariate analysis.

Multivariate Analysis

Variable Candidate Model Selection

Table 2.
Selection of Candidate Variables for Multivariate Analysis

Age	0,703	Excluded from model
Education	0,979	Excluded from model
Knowledge	0,391	Excluded from model
Attitude	0,010	Included in model
Tenure	0,801	Excluded from model
Facilities and infrastructure	0,004	Included in model
Training	0,004	Included in model
SOP	0,002	Included in model
Supervision	0,004	Included in model

Based on the results of the variable selection process for multivariate analysis, variables with p -values < 0.25 were included in the model, while those with p -values > 0.25 were excluded. The variables that met the criteria and were included in the multivariate model were: attitude ($p = 0.010$), facilities and infrastructure ($p = 0.004$), training ($p = 0.004$), SOPs ($p = 0.002$), and supervision ($p = 0.004$). Conversely, the variables of age ($p = 0.703$), gender ($p = 0.633$), education ($p = 0.979$), knowledge ($p = 0.391$), and tenure ($p = 0.801$) had p -values > 0.25 and were therefore excluded from the multivariate model. Thus, five variables were identified as candidates for the multivariate analysis: attitude, facilities and infrastructure, training, SOPs, and supervision.

Multivariate Logistic Regression Analysis

Table 3.
Results of Multivariate Logistic Regression Analysis

		B	Sig.	Exp(B)	95% C.I. for EXP(B)	
					Lower	Upper
Step 1 ^a	Attitude	.460	.324	1.584	.635	3.949
	Facilities	.785	.085	2.193	.896	5.369
	Training	.848	.076	2.334	.915	5.956
	SOP	2.449	.003	11.576	2.343	57.182
	Controlling	.825	.083	2.282	.897	5.808
	Constant	-8.265	.000	.000		
Step 2 ^a	Facilities	.887	.046	2.428	1.017	5.795
	Training	.918	.051	2.504	.996	6.295
	SOP	2.453	.002	11.628	2.421	55.848
	Controlling	.883	.060	2.418	.963	6.070
	Constant	-7.908	.000	.000		

The logistic regression analysis results indicate that in Step 1, five variables were included in the model: attitude, facilities and infrastructure, training, SOPs, and supervision. The attitude variable had the highest p -value (0.324) and was therefore excluded from the model. In Step 2—the final model—facilities and infrastructure were significantly associated with compliance ($p=0.046$; $OR=2.428$; 95% CI 1.017–5.795), meaning that standard facilities and infrastructure increased the odds of compliance by a factor of 2.428. SOPs were also significantly associated with compliance ($p=0.002$; $OR=11.628$; 95% CI 2.421–55.848); the availability of SOPs increased the odds of compliance by a factor of 11.628 after controlling for other variables. Training ($p=0.051$; $OR=2.504$) and supervision ($p=0.060$; $OR=2.418$) did not show a significant association, as their p -values

exceeded 0.05 and their confidence intervals included the value of 1. Thus, facilities and infrastructure and SOPs are factors independently associated with compliance in solid medical waste management, with SOPs being the dominant factor due to having the highest Exp(B) value.

R Square analysis

Table 4.
R Square analysis

Subject	Value
Nagelkerke R Square	0,266
Cox & Shell R Square	0,180

Based on the logistic regression analysis, a Nagelkerke R-Square value of 0.266 was obtained. This indicates that the variables included in the model account for 26.6% of the variation in compliance with solid medical waste management, while the remaining 73.4% is influenced by variables not examined in this study. Meanwhile, the Cox & Snell R-Square value of 0.180 indicates that the independent variables in the model explain 18.0% of the variation in compliance with solid medical waste management. In logistic regression, the Nagelkerke R-Square value is more commonly used because it is adjusted to yield a range between 0 and 1. Thus, the model's capacity to explain compliance with solid medical waste management is considered limited, at 26.6%.

Analysis of Compliance Probability

This logistic regression model describes the relationship between independent variables and the probability of compliance—expressed as a linear combination of predictor factors—formulated as follows:

$$y = -7.908 + 0.887 (\text{Facilities and Infrastructure}) + 0.918 (\text{Training}) + 2.453 (\text{SOP}) + 0.883 (\text{Supervision})$$

Table 5.
Compliance Probability Analysis Results

No.	Facilities	Training	SOP	Controlling	Probability Compliance
1	Non Standard	None	None	None	5,91%
2	Non Standard	None	None	Good	13,19%
3	Non Standard	None	Present	None	42,21%
4	Non Standard	None	Present	Good	63,85%
5	Non Standard	Present	None	None	13,60%
6	Non Standard	Present	None	Good	27,57%
7	Non Standard	Present	Present	None	64,66%
8	Non Standard	Present	Present	Good	81,56%
9	Standard	None	None	None	13,24%
10	Standard	None	None	Good	26,95%
11	Standard	None	Present	None	63,95%
12	Standard	None	Present	Good	81,09%
13	Standard	Present	None	None	27,65%
14	Standard	Present	None	Good	48,03%
15	Standard	Present	Present	None	81,62%
16	Standard	Present	Present	Good	91,48%

Based on the prediction results, the lowest probability of compliance was 5.91% under conditions characterized by non-standard facilities and infrastructure, the absence of training and SOPs, and poor supervision. Conversely, the highest probability of compliance reached 91.48% when facilities and infrastructure met standards, training and SOPs were available, and supervision was effective. In general, the quality of facilities, infrastructure, training, SOPs, and supervision is positively correlated with the probability of compliance in solid medical waste management. The presence of SOPs appears to yield the greatest increase in the probability of compliance compared to the other variables. Staff compliance regarding solid medical waste management is influenced by the interplay of individual characteristics, knowledge, attitudes, facilities, training, work guidelines, workload, and hospital management support (Hutajulu et al., 2025). Medical waste management is a complex process

encompassing segregation at the source, containment, collection, transportation, storage, treatment, and final disposal, all of which require integrated policy and resource support (Alrabiah et al., 2025). Recent research also indicate that a lack of knowledge, training, facilities, personnel, funding, and supervision constitutes a major barrier to medical waste management in hospitals (Islam et al., 2025; Alshagrawi & Alahmari, 2025).

Relationship Between Age and Compliance with Solid Medical Waste Management

The study results show that compliance among staff aged over 40 was 77.4%, while compliance among those aged under 40 was 74.1%; with a p-value of 0.886, there is no significant relationship between age and compliance with solid medical waste management (Primary research data, 2026). Theoretically, advancing age can enhance an individual's maturity of thought, experience, and ability to comprehend occupational risks; however, age does not always directly result in compliant work behavior (Wang et al., 2025). Wang et al. found that age did not make a significant difference regarding knowledge, attitudes, and practices concerning medical waste classification, although work experience could improve knowledge of segregation procedures (Wang et al., 2025). These findings indicate that compliance is influenced more by exposure to procedures, training, and institutional support than by age alone (Hutajulu et al., 2025). In the field setting at the Inpatient Unit of RSUP Dr. Mohammad Hoesin Palembang, all staff operate under relatively identical systems, SOPs, and waste management facilities, regardless of age group. Errors in segregation—such as the mixing of syringes, IV fluid bottles, and IV tubing with domestic waste—can occur among staff across all age groups if facilities and supervision do not adequately support the implementation of procedures (Islam et al., 2025). The researchers hypothesize that the absence of a significant relationship is due to the fact that the difference in compliance proportions between the two age groups was only 3.3%. Age is not a factor that directly facilitates waste segregation by personnel; conversely, the availability of containers, safety boxes, SOPs, training, and supervision is more closely associated with personnel behavior during waste generation (Alshagrawi & Alahmari, 2025).

The Relationship Between Education and Compliance with Solid Medical Waste Management

Research results indicate that compliance among staff with a Diploma III (D-III) education was 75.0%, while compliance among staff with a Bachelor's/Professional/Master's (S1/Profesi/S2) education was 74.8%; with a p-value of 1.000, there is no significant relationship between education and compliance with solid medical waste management (Primary research data, 2026). Theoretically, higher education can enhance an individual's ability to comprehend information, analyze risks, and adhere to workplace safety guidelines (Wang et al., 2025). Research by Wang et al. demonstrates that education is positively correlated with knowledge regarding medical waste classification; however, education does not automatically serve as a predictor of correct segregation practices (Wang et al., 2025). Furthermore, knowledge acquired through formal education does not necessarily encompass the specific technical waste management procedures applicable at each individual hospital (Hutajulu et al., 2025). In the field setting, staff members whether holding a D-III or an S1/Profesi/S2 qualification carry out service activities and waste segregation at locations that and adhered to the same hospital regulations. The nearly identical compliance rates indicate that differences in formal education levels do not result in significant differences in practice when staff receive similar orientation, information, and facilities. The researchers hypothesize that the absence of a relationship is due to the relatively homogeneous educational background of the respondents, as all were healthcare workers with professional training. Compliance with waste management practices relies more on technical competence—acquired through training, habituation, adherence to Standard Operating Procedures (SOPs), and supervision—than on formal education levels alone (Hutajulu et al., 2025; Islam et al., 2025).

Relationship Between Knowledge and Compliance with Solid Medical Waste Management

The study results show that compliance among staff with poor knowledge was 63.6%, while compliance among those with good knowledge was 75.8%; with a p-value of 0.468, there was no

significant relationship between knowledge and compliance regarding solid medical waste management (Primary research data, 2026). Knowledge provides staff with the foundation to recognize waste types, transmission risks, container color codes, the use of safety boxes, and correct waste disposal procedures (Islam et al., 2025). A study conducted at three hospitals in Indonesia found a significant relationship between knowledge and medical waste management compliance, with an adjusted OR of 1.503 (Hutajulu et al., 2025). Other research indicates that limited specific knowledge regarding waste classification can make it difficult for staff to distinguish between infectious, pathological, chemical, and pharmaceutical waste (Wang et al., 2025).

The results of this study differ from those of Hutajulu et al. because the majority of respondents (128 individuals) already possessed good knowledge, whereas only 11 staff members had poor knowledge. This unbalanced distribution resulted in limited variation in knowledge levels, thereby restricting the statistical ability to detect differences in compliance. Field observations revealed that despite the majority of staff possessing good knowledge, an average of 64 instances of improper waste segregation were still recorded monthly throughout 2025. This situation indicates a gap between knowing the procedures and actually implementing them during daily service activities. Research by Islam et al. similarly found that while staff may possess adequate knowledge and positive attitudes, their actual practices remain suboptimal due to factors such as limited facilities, high workloads, staffing shortages, and weak supervision (Islam et al., 2025). The researchers hypothesize that the absence of a significant association is attributable to the staff's knowledge being relatively homogeneous and falling within the "good" category. The persistent non-compliance is likely driven not merely by a lack of knowledge but also by established work habits, the demands of service delivery, limited access to waste receptacles, and insufficient reinforcement of behavior following the receipt of information (Alshagrawi & Alahmari, 2025).

Association Between Attitude and Compliance with Solid Medical Waste Management

The study results indicate that compliance among staff with a negative attitude was 62.0%, whereas compliance among those with a positive attitude was 82.0%; with a p-value of 0.016 and an OR of 2.796, a significant association was observed between attitude and compliance in the bivariate analysis (primary research data, 2026). Attitude reflects the acceptance, concern, and inclination of staff to respond to the importance of medical waste management (Wang et al., 2025). Staff with a positive attitude tend to view waste segregation as part of their professional responsibility, occupational safety, patient safety, and environmental protection (Islam et al., 2025). Research by Wang et al. indicates that a more positive attitude is associated with better waste classification practices and needs to be reinforced through organizational culture and feedback systems (Wang et al., 2025). In the field, the proportion of non-compliance among staff with a negative attitude reached 38.0%, whereas among those with a positive attitude, it was only 18.0%. This difference suggests that staff with greater awareness and concern regarding waste hazards tend to be more cautious when performing segregation. However, attitude was no longer significantly associated in the multivariate analysis after controlling for facilities and infrastructure, training, SOPs, and supervision ($p=0.324$). These results indicate that a positive attitude alone is insufficient to ensure compliance if the work environment does not provide the necessary facilities and guidelines (Alshagrawi & Alahmari, 2025). The researchers hypothesize that attitude was significant in the bivariate analysis because it influences staff willingness to follow procedures. The influence of attitude diminished in the multivariate analysis because staff willingness to comply remains dependent on the availability of adequate waste containers, training, SOPs, and supervision (Hutajulu et al., 2025).

The Relationship Between Length of Service and Compliance with Solid Medical Waste Management

Research results indicate that compliance among staff with less than five years of service was 73.8%, while compliance among those with more than five years of service was 75.6%; with a p-value of 0.956, there was no significant relationship between length of service and compliance (Primary

research data, 2026). Length of service can enhance staff experience, skills, and understanding of procedures performed repeatedly in the workplace (Wang et al., 2025). Wang et al. found that longer work experience is associated with increased knowledge regarding waste classification but is not necessarily directly linked to better segregation practices (Wang et al., 2025). Research by Hutajulu et al. also explains that findings regarding length of service vary because experience can be influenced by knowledge, training, habits, and organizational conditions (Hutajulu et al., 2025). In the field, both new and long-serving staff work using the same Standard Operating Procedures (SOPs) and facilities. New staff may lack sufficient experience but can acquire up-to-date information during orientation. Conversely, staff with longer tenure may possess more experience but also risk maintaining old habits that do not align with procedures if they do not receive refresher training (Hutajulu et al., 2025). The researchers hypothesize that the absence of a relationship exists because length of service does not always reflect the quality of experience gained by the staff. Work experience improves compliance when accompanied by the reinforcement of correct habits, periodic training, evaluation, and feedback from the hospital (Alshagrawi & Alahmari, 2025).

The Relationship Between Facilities/Infrastructure and Compliance with Solid Medical Waste Management

Research results show that compliance among staff working with non-standard facilities/infrastructure was 59.6%, whereas compliance among staff working with standard facilities/infrastructure was 82.6% ($p=0.006$; $OR=3.223$), indicating a significant relationship between facilities/infrastructure and compliance (Primary research data, 2026). Facilities and infrastructure serve as enabling factors that directly facilitate staff in performing waste segregation according to standards. Required facilities include color-coded containers, waste bags, labels, hazard symbols, safety boxes, personal protective equipment (PPE), and safe internal transport equipment (Islam et al., 2025). Limitations regarding containers, PPE, personnel, budget, and transport equipment have been identified as major barriers to medical waste management in hospitals (Islam et al., 2025; Alshagrawi & Alahmari, 2025). In the multivariate analysis, facilities and infrastructure remained significantly associated with compliance ($p=0.046$; $Exp(B)=2.428$). These results indicate that standard facilities/infrastructure increase the odds of staff compliance by a factor of 2.428 after controlling for training, SOPs, and supervision. Field observations revealed the presence of medical waste—such as syringes, IV bottles, and IV tubing—mixed with domestic waste at temporary storage sites. These findings suggest issues with segregation at the source, potentially linked to the quantity, condition, location, accessibility, or suitability of the available containers. Research conducted at two hospitals also found that containers lacking lids, lacking labels, or being difficult to access were associated with poor segregation practices (Islam et al., 2025). Researchers assume that infrastructure and facilities are linked to compliance because they directly address the needs of staff when disposing of waste. Staff find it easier to adhere to procedures when receptacles are available near the point of service, are not overfilled, bear clear labels, and are appropriate for the specific type of waste generated (Islam et al., 2025). Conversely, limited facilities can lead to non-compliance, even when staff possess adequate knowledge and positive attitudes (Alshagrawi & Alahmari, 2025).

The Relationship Between Training and Compliance with Solid Medical Waste Management

Research results indicate that compliance among staff who did not receive training was 60.8%, whereas compliance among those who did receive training was 83.0%; with a p -value of 0.007 and an OR of 3.140, a significant relationship was found in the bivariate analysis (primary research data, 2026). Training enhances technical knowledge, skills, sorting accuracy, the use of personal protective equipment, and staff's sense of responsibility in adhering to waste management procedures (Hutajulu et al., 2025). A study across three hospitals in Indonesia found that training was the dominant factor influencing nurses' compliance with medical waste management protocols (Hutajulu et al., 2025). Intervention studies also demonstrate that training can improve staff awareness and practices regarding infection control and waste management (Das et al., 2025).

In the multivariate analysis, training yielded a p-value of 0.051, an Exp(B) of 2.504, and a 95% CI of 0.996–6.295, meaning it was not statistically significant at the 5% level. Nevertheless, the p-value being very close to 0.05 and the Exp(B) value of 2.504 indicate that training still holds practical significance regarding compliance. In the field, the non-compliance rate among staff who did not receive training reached 39.2%, while non-compliance among those who received training was only 17.0%. This difference demonstrates that training provides the understanding and skills necessary for staff to execute procedures more accurately. The researchers hypothesize that training lost its statistical significance in the final model because its effectiveness is influenced by the presence of Standard Operating Procedures (SOPs), facilities, and supervision. Staff who have undergone training may still make errors if waste containers are unavailable or if the training outcomes are not reinforced through routine supervision and evaluation (Islam et al., 2025). Differences in the quality, frequency, methods, and timing of training delivery can also result in varying training impacts across individual staff members (Alshagrawi & Alahmari, 2025).

The Relationship Between SOPs and Compliance with Solid Medical Waste Management

Research results indicate that staff compliance when SOPs were unavailable was only 30.0%, whereas compliance when SOPs were available stood at 78.3% ($p=0.003$; $OR=8.417$), demonstrating a significant relationship between SOPs and compliance (Primary research data, 2026). SOPs provide standardized guidelines regarding the segregation, containment, labeling, use of safety boxes, collection, transportation, storage, and management of medical waste exposure. The availability of clear guidelines and policies is a crucial component of medical waste management, as it minimizes procedural variations among staff and service units (Alrabiah et al., 2025). The absence of clear regulations, guidelines, and defined responsibilities has been identified as a barrier to implementing safe medical waste management (Alshagrawi & Alahmari, 2025).

Multivariate analysis confirmed a significant relationship between SOPs and compliance ($p=0.002$; $Exp(B)=11.628$). These results indicate that the availability of SOPs increases the odds of compliance by a factor of 11.628, even after controlling for infrastructure, training, and supervision. Based on the highest Exp(B) value, SOPs are the most dominant factor associated with compliance in solid medical waste management. Institutionally, RSMH already possesses policies and SOPs for waste management; however, the study found respondents who stated that SOPs were unavailable. This situation suggests that SOPs may not be posted at all service points, have not been evenly disseminated, are difficult to access, or remain unknown to some staff members. A 2025 study of government hospitals similarly found that weaknesses in policy, communication, coordination, and organizational governance hindered the effective implementation of medical waste management (Ernawati et al., 2025). The researchers posit that Standard Operating Procedures (SOPs) are a dominant factor, as they serve as the foundation for conducting training, assigning responsibilities, supervision, auditing, and providing feedback. In the absence of easily understood SOPs, personnel tend to act based on habit and individual interpretation, thereby increasing the risk of sorting non-compliance. The relatively wide confidence interval regarding SOPs requires cautious interpretation, given that the group lacking SOPs comprised only 10 respondents.

The Relationship Between Supervision and Compliance with Solid Medical Waste Management

Research results indicate that compliance among staff receiving poor supervision was 57.5%, whereas compliance among staff receiving good supervision was 81.8% ($p=0.006$; $OR=3.326$), demonstrating a significant relationship in the bivariate analysis (Primary research data, 2026). Supervision encompasses the processes of monitoring, assessment, guidance, and feedback provision to ensure staff consistently adhere to Standard Operating Procedures (SOPs). A study at Bhayangkara Level II Hospital in Medan found a significant association between monitoring and staff compliance with medical waste management (Nasution et al., 2025). Poor supervision, low management support, and a lack of follow-up have been identified as causes of non-compliance with waste management protocols in hospitals (Islam et al., 2025; Alshagrawi & Alahmari, 2025).

In the multivariate analysis, supervision yielded a p-value of 0.060, Exp(B) of 2.418, and a 95% CI of 0.963–6.070; thus, it was not statistically significant at the 5% level. However, the Exp(B) value suggests that good supervision tends to increase the odds of compliance by a factor of 2.418, even after controlling for other variables. In practice, the hospital conducted monitoring and recorded an average of 64 segregation non-conformities per month in 2025, with a peak of 95 findings in September 2025. The recurrence of these findings suggests that while supervision may successfully identify issues, it is not always accompanied by root cause analysis, feedback, guidance, and effective corrective actions. The researchers hypothesize that the relationship observed in the bivariate analysis exists because staff tend to be more disciplined when aware that their actions are being monitored and evaluated. The influence of supervision became insignificant after controlling for SOPs and facilities, as supervision requires guidelines and resources to serve as a basis for assessing compliance. Supervision cannot function optimally if staff lack clear SOPs or the necessary facilities to implement the supervisor's recommendations (Alshagrawi & Alahmari, 2025).

Multivariate Analysis Results

The final logistic regression model comprised facilities, training, SOPs, and supervision, whereas "attitude" was excluded due to having the highest p-value. Facilities and SOPs were significantly associated with compliance, while training and supervision yielded p-values slightly above 0.05. These results indicate that compliance with solid medical waste management at the RSMH Inpatient Unit is determined more strongly by organizational systems than by the individual characteristics of the staff. Recent research in Indonesia also indicates that compliance is influenced by a combination of knowledge, perceptions, workload, facilities, and training; therefore, improvements cannot be directed solely at individuals (Hutajulu et al., 2025). A 2025 qualitative study identified that management support, the availability of guidelines, periodic training, facilities, staffing, and supervision are interconnected elements in medical waste management (Alshagrawi & Alahmari, 2025). The researchers posit that compliance is not merely a matter of staff willingness but also depends on the hospital system's ability to provide conditions that enable compliance. Staff members with adequate knowledge and positive attitudes may still commit errors if necessary facilities are unavailable, SOPs are unknown, training is not sustained, and supervision is not accompanied by feedback.

Model Capability

The Nagelkerke R-Square value of 0.266 indicates that facilities, training, SOPs, and supervision explain 26.6% of the variation in compliance with solid medical waste management. The remaining 73.4% of the variation is likely influenced by other variables not included in this study. These other factors may include workload, staffing levels, staff-to-patient ratios, service volume, work shifts, motivation, safety culture, leadership, rewards, sanctions, and management commitment. Research by Hutajulu et al. found a significant relationship between workload and compliance, as time pressure can lead staff to neglect waste segregation steps (Hutajulu et al., 2025). Studies by Islam et al. also identified high workloads, limited staffing, and a lack of funds, facilities, and supervision as barriers to proper waste management practices (Islam et al., 2025). The researchers hypothesize that segregation errors at RSMH may increase during peak service hours or emergency situations, as staff attention is primarily focused on patient care. The variables of workload, safety culture, and head nurse commitment require further investigation to enhance the model's ability to explain compliance.

Probability of Compliance

The lowest probability of compliance (5.91%) occurs under conditions where facilities and infrastructure are substandard, and there is a lack of training, SOPs, and effective supervision. Conversely, the highest probability of compliance (91.48%) occurs when facilities and infrastructure meet standards, and training, SOPs, and effective supervision are all in place. The increase in probability across various combinations indicates that improving waste management requires simultaneous interventions. Recent systematic reviews emphasize that medical waste management

necessitates the integration of policies, staff knowledge, training, facilities, technology, and organizational governance (Alrabiah et al., 2025). The presence of SOPs yields the most significant increase in probability, as they serve as the foundation linking facilities, training, and supervision. The researchers posit that merely providing SOPs is insufficient without accompanying dissemination, training, adequate facilities, and periodic audits. Optimal results are achieved when all organizational elements are functioning effectively, as evidenced by the 91.48% compliance probability. This probability value is a prediction based on the study's respondent characteristics and requires validation before application to other populations or hospitals.

Research Implications

Hospitals need to prioritize the availability and implementation of Standard Operating Procedures (SOPs) in every inpatient ward, as SOPs are the most dominant factor in the research model. SOPs should be placed in highly visible locations, communicated to all staff, and used as a basis for training and evaluation. Facilities and infrastructure need to be audited based on type, quantity, condition, color coding, lids, labeling, location, and ease of access for staff. Limited facilities and logistics have proven to be significant barriers to the implementation of safe waste segregation (Islam et al., 2025). Training should be conducted periodically using methods such as demonstrations, simulations, and practice evaluations, rather than relying solely on the delivery of instructional material. Structured training can enhance staff competence, awareness, skills, and accountability regarding waste management (Das et al., 2025; Hutajulu et al., 2025). Supervision needs to evolve from merely recording findings into a system of auditing and follow-up that encompasses root cause analysis, feedback, mentoring, recognition, and corrective actions. Monitoring and the provision of appropriate information have been shown to correlate with improved staff compliance in medical waste management (Nasution et al., 2025). The implementation of integrated interventions is expected to reduce incidents of medical waste mixing with domestic waste at RSUP Dr. Mohammad Hoesin Palembang.

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