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Original Research

NURSES' KNOWLEDGE, ATTITUDES, AND BEHAVIOR IN SOLID MEDICAL WASTE SEGREGATION AT KLUNGKUNG HOSPITAL

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ABSTRACT

Nurses' Knowledge, Attitudes, and Behavior in Solid Medical Waste Segregation at Klungkung Hospital. *Improper segregation of solid medical waste in hospitals increases the risk of occupational injuries, nosocomial infections, and environmental pollution. Nurses play a key role in waste segregation, particularly in inpatient wards where medical waste is generated intensively. This study aimed to analyze the relationship between knowledge and attitudes with nurses' behavior in solid medical waste segregation in inpatient wards at Klungkung District General Hospital. A quantitative cross-sectional study was conducted from January to June 2024 involving 71 nurses selected using proportional non-probability sampling. Data were collected using structured questionnaires to assess knowledge and attitudes, and observation checklists to assess behavior. Data were analyzed using Chi-square tests and contingency coefficients. Most nurses had good knowledge (67.6%), positive attitudes (80.3%), and good segregation behavior (78.9%). Significant relationships were found between knowledge and attitude ($p < 0.001$), knowledge and behavior ($p < 0.001$), and attitude and behavior ($p < 0.001$). Additional descriptive findings indicated that lack of understanding and time constraints hindered proper segregation, while awareness of health hazards, personal responsibility, and sanctions encouraged compliance. Nurses' knowledge and attitudes were significantly associated with their behavior in solid medical waste segregation. Strengthening education, improving facilities, and consistent supervision are essential to enhance sustainable waste segregation practices in hospitals.*

INTRODUCTION

Hospitals play a crucial role in supporting health development by providing essential healthcare services, but they also present significant public health challenges. Hospitals, as public health facilities, serve both sick and healthy individuals, creating risks for disease transmission and environmental contamination [1,2]. The Regulation of the Ministry of Health Number 56 of 2014 mandates hospitals to provide inpatient, outpatient, and emergency services [2], while the Law of the Republic of Indonesia Number 44 of 2009 highlights the need for continuous improvement in service quality and accessibility [1].

Healthcare services generate significant amounts of medical waste, including hazardous materials such as infectious waste, sharps, pharmaceuticals, and chemicals (2,5). This waste, classified as hazardous under the Regulation of the Ministry of Health Number 2 of 2023, can pollute the environment and pose health risks [6]. The World Health Organization categorizes medical waste into different types, each presenting varying risks, including infectious, sharps, and pharmaceutical waste [7]. Proper management of this waste, especially through source segregation, is crucial in preventing contamination and reducing occupational health risks [8,9].

Improper medical waste management, including inadequate segregation, increases the risk of disease transmission and environmental contamination [29]. Studies have shown that poor waste segregation allows infectious waste to contaminate non-infectious waste streams, exposing healthcare workers and waste handlers to infectious pathogens [10,11,12,13]. Therefore, effective waste management is essential for protecting hospital staff, patients, and the general public. Nurses, being directly involved in patient care and waste generation, play a central role in this process. Adequate knowledge and proper attitudes are necessary for minimizing occupational risks, although challenges such as inadequate staff training, limited resources, and insufficient safety measures often hinder proper execution [14,15].

Previous studies have yielded mixed results regarding the relationship between knowledge, attitudes, and medical waste management behavior. Some studies indicate a significant link between nurses' knowledge and their waste management behavior [16], while others suggest that attitude and practice are more closely related to waste management practices [17]. This highlights the need for further research on how knowledge, attitude, and behavior interact in medical waste management.

Klungkung District General Hospital in Bali, Indonesia, generates substantial amounts of medical waste, with inpatient wards producing an average of 170 kilograms of waste per month (IKLRS). Observations in 2023 revealed that solid medical waste segregation was not optimally implemented, with frequent instances of medical waste found in non-medical waste bins. This improper segregation poses significant risks to public health, including contamination of disposal sites and increased occupational hazards for waste handlers [18,19].

Given the crucial role of nurses in medical waste segregation, this study aimed to analyze the relationship between nurses' knowledge, attitudes, and behavior in the segregation of solid medical waste in the inpatient wards at Klungkung District General Hospital. This study provides a specific contextual contribution by mapping the behavioral barriers and motivating factors among inpatient nurses in Bali, offering targeted empirical evidence to improve regional hospital environmental health policies and practical operational supervision.

MATERIALS AND RESEARCH METHODS

This study employed a quantitative research design with a cross-sectional approach to examine the relationship between nurses' knowledge and attitudes as independent variables and their behavior in solid medical waste segregation as the dependent variable at a single point in time. The conceptual framework of this study was developed based on Lawrence Green's behavioral theory [20,21], which states that behavior is influenced by predisposing factors (knowledge and attitudes), enabling factors (facilities and infrastructure), and reinforcing factors (regulations and supervisory personnel). In this study, knowledge and attitudes were the main variables analyzed, while enabling and reinforcing factors were not examined.

The research was conducted in the inpatient wards of Klungkung District General Hospital from January to June 2024 after obtaining ethical clearance and institutional permission. The study population consisted of all nurses working in the inpatient wards of the hospital, totaling 240 nurses distributed across eleven inpatient wards. The sample size was

determined using the Slovin formula with a margin of error of 10%, resulting in a minimum sample size of 71 nurses. A non-probability sampling technique was applied, specifically proportional sampling. Samples were selected proportionally from each inpatient ward based on the number of nurses assigned to that ward, ensuring that wards with a higher number of personnel and patient loads contributed more respondents to achieve a representative distribution across all units.

Primary data were collected using two instruments: a structured questionnaire and an observation checklist. The questionnaire was administered online using Google Forms and consisted of two sections. The knowledge questionnaire contained 12 multiple-choice questions related to solid medical waste segregation, with correct answers scored as 1 and incorrect answers as 0. Knowledge levels were categorized as sufficient (scores 1–6) and good (scores 7–12). The attitude questionnaire consisted of 10 statements with "agree" and "disagree" responses, scored as 1 and 0, respectively, and categorized as poor (scores 1–5) and good (scores 6–10).

Nurses' behavior in solid medical waste segregation was assessed through direct observation using a checklist containing seven items. Each item was scored as 1 (performed) or 0 (not performed). Behavior was categorized as good if all seven items were performed and poor if one or more items were not performed. This strict threshold was applied because the omission of even a single segregation step can compromise the entire waste management process, rendering the segregated waste contaminated and significantly increasing the risk of occupational exposure and nosocomial infections. Observations were conducted during routine nursing activities in treatment rooms.

Secondary data included hospital profiles and demographic information of nurses obtained from hospital records. Data processing involved editing, coding, entry, and tabulation. Data analysis was performed using statistical software.

RESEARCH RESULTS AND DISCUSSION

Table 1 showed that the majority of respondents were female nurses (60.6%), while male nurses accounted for 39.4%. In terms of educational level, more than half of the respondents had a Diploma III in Nursing (52.1%), followed by professional nurses (Ners) at 39.4%, with a smaller proportion holding a Diploma IV or Bachelor's degree in Nursing (8.5%). Regarding age distribution, most respondents were in the 25–32 year age group (56.3%), followed by those aged 33–40 years (28.2%), with fewer respondents in the older age groups.

Table 1 Characteristics of Respondents (N = 71)

Category	Frequency (n)	Percentage (%)
Gender		
Female	43	60.6
Male	28	39.4
Educational Level		
Diploma III in Nursing	37	52.1
Diploma IV / Bachelor in Nursing	6	8.5
Professional Nurse (Ners)	28	39.4
Age (years)		
25–32	40	56.3
33–40	20	28.2
41–48	8	11.3
49–56	3	4.2

These findings indicated that the study population was predominantly composed of relatively young, female nurses with diploma-level education, reflecting a productive workforce profile. This demographic composition may have influenced levels of knowledge, attitudes, and behaviors toward solid medical waste segregation and should be considered when interpreting the study results and planning targeted training or intervention programs.

Table 2 Distribution of Nurses' Knowledge, Attitudes, and Behavior in Solid Medical Waste Segregation (N = 71)

Variable	Category	Frequency (n)	Percentage (%)
Knowledge Level	Good	48	67.6
	Sufficient	23	32.4
Attitude	Good	57	80.3
	Poor	14	19.7
Behavior	Good	56	78.9
	Poor	15	21.1

Table 2 indicated that most nurses demonstrated a good level of knowledge regarding solid medical waste segregation (67.6%), although nearly one-third of respondents (32.4%) still had only sufficient knowledge. This pattern was consistent with the distribution of attitudes and behaviors, in which the majority of nurses showed positive attitudes (80.3%) and good segregation behavior (78.9%). Nevertheless, a notable proportion of respondents still exhibited poor attitudes (19.7%) and inappropriate practices (21.1%), suggesting that favorable outcomes had not yet been achieved uniformly among all nurses.

Although the overall knowledge level was high, the presence of nurses with only sufficient knowledge highlights gaps, especially in understanding the fundamental aspects of waste segregation and the health risks, such as exposure to sharps, associated with improper handling. Proper knowledge of biomedical waste categorization and disposal protocols is crucial for effective waste sorting. Studies indicate that when nurses are well-informed about waste management guidelines, such as the importance of color coding and the hazards of improper disposal, compliance with waste segregation practices improves significantly [22,23]. Adequate training and regular educational updates reinforce both the theoretical and practical aspects of waste management, leading to safer and more efficient waste handling behaviors [14]. This knowledge helps nurses understand the risks of mismanagement, thereby reducing potential hazards to themselves and others [22].

Nurses' attitudes toward medical waste management significantly influence their daily practices. Nurses with positive attitudes toward waste sorting tend to adhere more closely to established protocols and safety measures [14]. Studies have shown that nurses committed to biosafety and infection control are more likely to engage in thorough waste segregation [24]. A focus on personal and public health safety encourages a culture where proper waste management practices are expected and normalized, fostering a safer and more environmentally responsible hospital environment [24].

The behavior of nurses, shaped by both knowledge and attitudes, directly impacts waste management practices. Empirical studies show that nurses who consistently practice proper waste sorting such as correctly segregating and disposing of hazardous materials significantly reduce the incidence of nosocomial infections and environmental contamination [22]. Additionally, adhering to waste disposal protocols lowers the risk of exposure to infectious agents and toxic substances [14]. By maintaining consistent waste sorting practices, nurses help create a safer and more sustainable environment for patients and healthcare workers alike [24].

Table 3 Association between Knowledge Level and Nurses' Attitudes

Independent Variable	Category	Attitude		p-value	CC
		Poor n (%)	Good n (%)		
Knowledge Level	Sufficient	13 (56.5)	10 (43.5)	<0.001	0.539
	Good	1 (2.1)	47 (97.9)		

Table 3 revealed a significant link between nurses' knowledge levels and their attitudes toward solid medical waste segregation. Nurses with sufficient knowledge were more likely to exhibit poor attitudes (56.5%) compared to those with good attitudes (43.5%). In contrast, nearly all nurses with good knowledge demonstrated positive attitudes (97.9%), with only a small percentage showing poor attitudes (2.1%). Statistical analysis using the Chi-square test confirmed the significance of this relationship ($p < 0.001$), with a strong association indicated

by the contingency coefficient. These findings suggest that higher knowledge levels are closely associated with more positive attitudes toward proper waste segregation.

Numerous empirical studies on healthcare workers' knowledge, attitudes, and practices have consistently shown that greater knowledge of biomedical or solid waste management guidelines correlates with more positive attitudes toward their proper implementation [22]. Nurses who receive thorough training and regularly update their knowledge are more aware of the risks of improper waste segregation and understand the importance of adhering to protocols. This knowledge helps reduce uncertainty and reinforces the view of waste sorting as a critical component of patient and environmental safety [23].

Research also indicates that knowledge gained through formal training and on-the-job experience is a key factor in shaping attitudes that favor compliance with waste management policies [22,25]. Nurses who are well-versed in waste categorization, color coding, and specific handling procedures tend to exhibit more positive attitudes toward waste sorting. This relationship is likely influenced by increased confidence in performing the task correctly, a sense of personal responsibility, and a reduced perception of risk when following proper procedures. Thus, positive attitudes are not just abstract beliefs but translate into tangible actions, such as adherence to waste management protocols, reducing the potential for cross-contamination and occupational hazards [22].

Table 4 Association between Knowledge and Attitude with Nurses' Behavior

Independent Variable	Category	Behavior		p-value	CC
		Poor n (%)	Good n (%)		
Knowledge Level	Sufficient	13 (56.5)	10 (43.5)	<0.001	0.515
	Good	2 (4.2)	46 (95.8)		
Attitude	Poor	14 (100.0)	0 (0.0)	<0.001	0.692
	Good	1 (1.8)	56 (98.2)		

Further analysis in Table 4 showed a significant link between nurses' knowledge, attitudes, and behavior. Nurses with sufficient knowledge were more likely to demonstrate poor behavior (56.5%) compared to good behavior (43.5%). In contrast, most nurses with good knowledge (95.8%) exhibited appropriate waste segregation practices. The Chi-square test confirmed a statistically significant relationship between knowledge and behavior ($p < 0.001$), supported by the contingency coefficient.

Attitude also strongly influenced behavior. All nurses with poor attitudes showed poor waste segregation behavior, while none demonstrated good behavior. Conversely, nearly all nurses with positive attitudes (98.2%) followed proper segregation practices, with only a small proportion displaying poor behavior (1.8%). This relationship was statistically significant ($p < 0.001$), highlighting the key role attitudes play in shaping behavior.

Numerous empirical studies have consistently shown that comprehensive knowledge of biomedical waste management guidelines forms the foundation for positive attitudes and proper segregation behavior. Nurses who receive thorough training are more aware of the risks of improper segregation, which reinforces their view of waste sorting as a critical component of safety [22,23]. This knowledge reduces uncertainty and builds confidence, translating into tangible actions that minimize cross-contamination and occupational hazards [14].

Furthermore, attitudes act as a key mediator between knowledge and behavior. When nurses perceive waste sorting as essential for personal and public safety, their commitment to following protocols increases [26]. The synergy of applied knowledge and positive attitudes creates an environment conducive to strict adherence, ultimately enhancing the effectiveness of hospital waste management programs [22,23]. This is in line with broader environmental studies demonstrating that building ecological awareness is essential for reorienting long-term waste management behavior [30].

Table 5 Distribution of Respondents' Answers Regarding Reasons for Segregating or Not Segregating Medical Waste (N = 71)

Reason	n	%
Question 1: Reasons for Not Segregating Waste		
Lack of understanding	32	45.0
Laziness	15	21.0
In a hurry	13	18.0
Pedal-type waste bin not functioning properly	7	10.0
Others	4	6.0
Question 2: Reasons for Segregating Waste		
Awareness of potential hazards	37	52.0
Awareness / personal responsibility	16	22.5
Presence of sanctions	9	12.5
Waste bins function properly	7	10.0
Others	2	3.0

As presented in Table 5, lack of understanding was the most frequently reported barrier to proper segregation (45.0%), followed by laziness (21.0%) and time constraints (18.0%). These findings suggest that non-compliance is driven by a combination of individual knowledge gaps and situational pressures [23,27]. Regional studies in Bali confirm that identifying these driving and inhibiting factors at the source is critical for formulating effective waste segregation strategies [31]. In busy hospital settings, high workloads can cause nurses to prioritize immediate clinical duties over waste sorting [28]. Additionally, malfunctioning equipment, such as broken pedal-type bins (10.0%), exacerbates the issue by hindering the physical sorting process [28]. Providing appropriate, integrated, and functional disposal solutions is a fundamental requirement for tackling waste management issues effectively [33].

Conversely, the primary motivators for segregation were awareness of potential health hazards (52.0%) and personal responsibility (22.5%) (27). The presence of organizational sanctions (12.5%) and functional waste bins (10.0%) also contributed to compliance [14,25]. This demonstrates that risk perception and a strong sense of professional duty, supported by functional infrastructure and clear regulations, are the most effective drivers for sustaining proper medical waste management practices [14,27].

CONCLUSIONS AND RECOMMENDATIONS

This study concluded that nurses' knowledge and attitudes were significantly associated with their behavior in solid medical waste segregation in inpatient wards at Klungkung District General Hospital. Specifically, awareness of health hazards and a sense of personal responsibility emerged as the most influential driving factors for compliance, whereas knowledge gaps and clinical time constraints served as the primary barriers. Improving nurses' behavior requires an integrated approach. It is recommended that hospitals strengthen continuous education programs, ensure the prompt maintenance of disposal facilities, and enforce consistent operational supervision to support sustainable waste segregation practices. Furthermore, empowering hospital staff through targeted programs can transform waste management from a routine task into a sustainable, value-driven practice [32].

ETHICAL APPROVAL

This study obtained ethical approval from the Health Research Ethics Committee of Poltekkes Kemenkes Denpasar (Komisi Etik Penelitian Kesehatan Poltekkes Denpasar), under reference number DP.04.02/F.XXXII.25/ 0455 /2024.

CONFLICT OF INTEREST

The authors declare that there is no conflict of interest regarding the research reported in this paper.

AUTHOR CONTRIBUTIONS

IKGS: conceptualisation, study design, literature search, data extraction, data analysis, and manuscript writing; IGAW, IKS, and MCH: supervision, data validation, critical review, and final manuscript review. All authors read and approved the final manuscript.

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