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MORALITY BEFORE KNOWLEDGE

Optimization of medical waste management systems in community health centers: Challenges, strategies, and sustainable solutions

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ABSTRACT

Background: Public health services are classified as public goods, primarily aimed at maintaining and improving health and preventing diseases, without neglecting disease treatment and health recovery. These services include disease control, environmental sanitation, nutritional improvement, family health enhancement, family planning, mental health, and various other public health programs, such as health promotion. On the other hand, individual health services are considered private goods, with the main objective of curing diseases and restoring individual health, while still considering health maintenance and disease prevention. **Methods**: Based on the data analysis to be conducted, this study is analytical in nature, as it aims to examine hypotheses and provide a deeper interpretation of the relationship between the dependent and independent variables. **Findings:** This study found that although there is compliance with waste management procedures, issues remain in waste collection, storage, and treatment. A lack of staff training and awareness, limited resources, and weak monitoring and evaluation systems hinder the overall effectiveness of waste management. Furthermore, community participation and awareness are still low. Therefore, improvements are needed in staff training, resource allocation, technological utilization, and community engagement to enhance future waste management practices. **Conclusion**: The implementation of medical waste management at community health centers (*Puskesmas*) complies with the medical waste management standards set by the Indonesian Ministry of Health. However, several aspects have not been fully met. These include the absence of medical waste symbols on waste bins in some Puskesmas, the lack of dedicated medical waste transport tools such as carts or trolleys in all facilities, and the use of ambulances as waste transport vehicles in some Puskesmas. **Novelty/Originality of this article:** This study presents innovations in medical waste management at community health centers in Bulukumba by integrating digital technology, a holistic training approach, and ecosystem principles to promote environmental sustainability.

KEYWORDS: attitudes; knowledge; medical waste; medical waste management implementation; staff.

1. Introduction

Public health services are classified as public goods, with the primary objectives of maintaining and improving health and preventing diseases, without neglecting disease treatment and health recovery. These services include disease eradication, environmental sanitation, nutritional improvement, family health promotion, family planning, mental health, and various other public health programs, such as health promotion. In contrast,

individual health services are considered private goods, mainly aimed at curing diseases and restoring individual health, without disregarding health maintenance and disease prevention (Ministry of Health of the Republic of Indonesia (Depkes RI, 2009).

The government, society, and private sector share responsibility for health development according to their respective roles and functions. The primary public health service delivery is the responsibility of the district or city health offices, whose operational implementation may be delegated to community health centers (Puskesmas) (Depkes RI, 2009). Puskesmas serve as technical implementing units of district or city health offices located at the sub-district level to carry out operational health development tasks. The establishment of Puskesmas in each sub-district plays a vital role in maintaining public health.

Hospital and Puskesmas waste are considered potential vectors for the spread of infectious diseases (Adisasmito, 2007; Ariyanto, 2007; Mar'atus & Sholikah, 2003). Waste can harbor pathogenic organisms and become breeding grounds for insects and rodents. Additionally, the waste contains toxic chemicals and sharp objects that pose health risks and injury hazards. Dust particles in the waste may cause air pollution, spreading pathogens and contaminating medical equipment and food (Depkes RI, 1997). Hospital and Puskesmas waste can be classified into non-medical and medical waste. Non-medical waste has characteristics similar to waste generated by household and general community environments (Adikoesoemo, 1997). In hospital and Puskesmas settings, non-medical waste may originate from offices/administrative areas, service units, nutrition/kitchen units, and outdoor premises (Depkes RI, 1997).

The ministry of health has issued ministerial decree No. 1204 of 2004 concerning Environmental Health Requirements for Hospitals, mandating hospitals and Puskesmas to manage their waste properly. Midwife practices, medical and dental practices, health clinics, and maternity homes also generate small amounts of infectious sharp waste (containing hazardous materials). The management principle for hazardous waste (B3) is "from cradle to grave," encompassing waste storage, collection, transportation, treatment, and disposal of treatment residues (Government Regulation No. 18 of 1999 in conjunction with Government Regulation No. 85 of 1999).

Regarding medical waste management at Puskesmas in Bulukumba Regency, several obstacles were identified based on the author's preliminary survey observations. These include occasional waste accumulation, the incomplete fulfillment of staff roles and functions resulting in some waste being inadequately handled, and the medical waste management system at the Puskesmas not yet being considered optimal due to incomplete facilities and infrastructure. Moreover, the management practices do not fully meet the required waste management system standards and are not always implemented in accordance with applicable regulations at these Puskesmas.

2. Methods

Based on the data analysis to be conducted, this study is analytical in nature as it aims to examine hypotheses and provide a deeper interpretation of the relationship between dependent and independent variables (Arikunto, 2006; Nazir, 2005). From the data collection perspective, this research is observational because the researcher only observes without applying any treatment (Budiarto, 2004). Regarding the timing of the study, the research design is cross-sectional, also known as a prevalence study, since both dependent and independent variables are measured simultaneously within a predetermined time frame (Bungin, 2005; Chandra, 2008).

3. Results and Discussion

3.1 Implementation of medical waste management at community health centers (puskesmas) in Bulukumba regency

Based on the Table 1, the observation results show that out of 7 community health centers (Puskesmas) located in rural areas of Bulukumba regency, 5 centers (71.4%) implemented the medical waste collection stage properly.

Table 1. Distribution of waste collection, transportation, storage, and disposal facilities at community health centers

No	*Puskesmas*/Health Center	Collection Facilities	Percentage (%)
Distribution of community health centers based on waste collection facilities			
1	Gattareng	Non-Compliant Waste Bins	28.6
2	Ponre	Non-Compliant Waste Bins	
3	Caile	Non-Compliant Waste Bins	
4	Ujung Loe	Non-Compliant Waste Bins	
5	Palangisang	Non-Compliant Waste Bins	71.4
6	Manyampa	Non-Compliant Waste Bins	
7	Bontonyeleng	Non-Compliant Waste Bins	
Distribution of community health centers based on on-site transportation facilities			
1	Gattareng	Plastic Bags	57.1
2	Ponre	Plastic Bags	
3	Caile	Plastic Bags	
4	Ujung Loe	Plastic Bags	
5	Palangisang	Plastic Bags	
6	Manyampa	Carts/Trolleys	28.6
7	Bontonyeleng	Carts/Trolleys	
Distribution of community health centers based on on-site transportation facilities			
1	Gattareng	Wearing Personal Protective Equipment (PPE)	57.1
2	Ponre	Wearing Personal Protective Equipment (PPE)	
3	Caile	Wearing Personal Protective Equipment (PPE)	
4	Ujung Loe	Wearing Personal Protective Equipment (PPE)	
5	Palangisang	Not Wearing Personal Protective Equipment (PPE)	
6	Manyampa	Not Wearing Personal Protective Equipment (PPE)	42.9
7	Bontonyeleng	Not Wearing Personal Protective Equipment (PPE)	
Distribution of community health centers based on waste storage facilities			
1	Gattareng	Temporary Storage Facility Not Available	42.9
2	Ponre	Temporary Storage Facility Not Available	
3	Caile	Temporary Storage Facility Not Available	
4	Ujung Loe	Temporary Storage Facility Available	
5	Palangisang	Temporary Storage Facility Available	
6	Manyampa	Temporary Storage Facility Available	57.1
7	Bontonyeleng	Temporary Storage Facility Available	
Distribution of community health centers based on off-site transportation facilities			
1	Gattareng	No Transportation Facility Available	42.9
2	Ponre	No Transportation Facility Available	
3	Caile	No Transportation Facility Available	
4	Ujung Loe	Ambulance	42.9
5	Palangisang	Ambulance	
6	Manyampa	Ambulance	
7	Bontonyeleng	Truck	14.3
Distribution of community health centers based on waste disposal facilities			
1	Gattareng	Manually Burned	42.9
2	Ponre	Manually Burned	
3	Caile	Manually Burned	
4	Ujung Loe	Incierator	57.1
5	Palangisang	Incierator	

6	Manyampa	Incierator
7	Bontonyeleng	Incierator

Based on the Table above, observational results indicate that out of 7 community health centers (Puskesmas) in Bulukumba Regency located in rural areas, only 2 Puskesmas (28.6%) conducted the transportation stage using carts/trolleys. The remaining centers used only plastic liner bags and bins for on-site transportation. Waste is transported daily with a frequency of once per day. The transportation is carried out by cleaning service staff, who handle the medical waste using complete personal protective equipment (PPE), including rubber gloves, face masks, head covers/helmets, boots, and specialized work uniforms. The distribution of Puskesmas based on on-site transportation facilities is presented in table 3 below. Based on the Table above, observational results indicate that out of 7 community health centers (Puskesmas) located in both rural and urban areas, 4 Puskesmas (57.1%) had waste management personnel (cleaning service) who used personal protective equipment (PPE) when handling medical waste. Based on the table above, observational results show that out of 7 community health centers (Puskesmas) in Bulukumba Regency located in rural areas, 4 Puskesmas (57.1%) carried out the temporary storage stage of medical waste management properly. The observational results indicate that out of 7 community health centers (Puskesmas) in Bulukumba Regency located in rural areas, 3 Puskesmas (42.9%) transported medical waste to the disposal site using an ambulance. Based on the table above, observational results show that out of 7 community health centers (Puskesmas) in Bulukumba Regency located in rural areas, 4 Puskesmas (57.1%) carried out medical waste disposal using an incinerator.

3.1.1 characteristics of personnel by age

Based on Table 2, all nurses (100%) are within the productive age range of 15–54 years. There are no nurses in the children (0–14 years) or elderly (≥ 54 years) age categories. This indicates that the entire nursing workforce in the observed group consists of individuals in their productive years, which may positively contribute to the effectiveness and efficiency of healthcare service delivery.

Table 2. Age distribution of nurses and waste management staff (cleaning service) in community health centers

No	Age	Total	Percentage
	Distribution of nurse characteristics by age		
1	Age 0–14 years (children)	-	-
2	Age 15–54 years (productive age)	17	100
3	Age ≥ 54 years (elderly)	-	-
	Total	17	100
	Distribution of waste management staff (cleaning service) characteristics by age		
1	Age 0–14 years (children)	-	-
2	Age 15–54 years (productive age)	9	90
3	Age ≥ 54 years (elderly)	1	1
	Total	10	100

Table 2 shows that the majority of waste management staff (cleaning service), totaling 90%, are within the productive age range of 15–54 years. Only 10% fall into the elderly category (≥ 54 years), and there are no staff members in the children age group (0–14 years). This indicates that most of the workforce is in their productive years, which can support optimal performance in waste management activities, although the presence of an elderly staff member may require additional considerations for workload and health.

3.1.2 Characteristics of personnel by educational level

Table 3 illustrates that the majority of nurses, accounting for 94.1%, have attained higher education, while only 5.9% have a secondary education background. None of the nurses have only a primary education. This suggests that the nursing workforce is generally well-educated, which may contribute to higher quality healthcare services and better patient outcomes.

Table 3. Educational level distribution of nurses and waste management staff (cleaning service) in community health centers

No.	Educational Level	Total	Percentage (%)
Distribution of nurse characteristics by educational level			
1.	Primary	-	-
2.	Secondary	1	5.9
3.	Higher Education	16	14
	Total	17	100
Distribution of waste management staff (cleaning service) characteristics by educational level			
1.	Primary	7	70
2.	Secondary	3	30
3.	Higher Education	-	-
	Total	10	100

Table 3 shows that the majority of waste management staff (cleaning service), accounting for 70%, have a primary education level. Meanwhile, 30% have attained a secondary education, and none have a higher education background. This indicates that the educational level of the waste management staff is relatively low, which may influence their understanding and implementation of more advanced waste management practices. Therefore, additional training and capacity-building efforts may be necessary to improve the effectiveness of their work.

3.1.3 Characteristics of personnel by years of service

Table 4 shows that the majority of nurses (76.5%) have more than 10 years of service, indicating a highly experienced workforce. Meanwhile, 23.5% have 1–5 years of service, and no nurses fall into the categories of ≤ 1 year or 6–10 years of service. This suggests that most nurses have long-standing experience, which can contribute positively to the quality and consistency of healthcare delivery. The distribution of years of service among the waste management staff is more evenly spread. 40% have more than 10 years of experience, while 20% each fall into the categories of ≤ 1 year, 1–5 years, and 6–10 years. This indicates a diverse range of experience levels within the team, which could be beneficial for balancing both experienced insight and newer perspectives in daily waste management operations.

Table 4. Distribution of years of service among nurses and waste management staff (cleaning service)

No.	Years Of Service	Total	Percentage (%)
Distribution of nurse characteristics by years of service			
1.	≤ 1 years	-	-
2.	1 – 5 years	4	23.5
3.	6 – 10 years	-	-
4.	≥ 10 years	13	76,5
	Total	17	100
Distribution of waste management staff (cleaning service) characteristics by years of service			
5.	≤ 1 years	2	20
6.	1 – 5 years	2	20
7.	6 – 10 years	2	20
8.	≥ 10 years	4	40
	Total	10	100

Table 5 shows that the majority of nurses (58.8%) have a high level of knowledge regarding medical waste management, while 41.2% have a moderate level of knowledge. None of the nurses fall into the low knowledge category. This indicates that nurses generally possess a strong understanding of medical waste management practices, which is essential for ensuring safety, compliance with health regulations, and environmental protection. In contrast, the majority of waste management staff (60%) have only a moderate level of knowledge about medical waste management, while 40% have a low level of knowledge. None have a high level of knowledge. This highlights a potential gap in understanding among cleaning service staff, which may impact the effectiveness and safety of medical waste handling. Targeted training and education programs are recommended to enhance their knowledge and improve overall waste management practices.

Table 5. Frequency distribution of knowledge levels in medical waste management among nurses and waste management staff (cleaning service)

No.	Knowledge	Total	Percentage (%)
Frequency distribution of nurses' knowledge in medical waste management			
1.	High	10	58.8
2.	Moderate	7	41.2
3.	Low	-	-
	Total	17	100
Frequency distribution of waste management staff's (cleaning service) knowledge in medical waste management			
4.	High	-	-
5.	Moderate	6	60
6.	Low	4	40
	Total	10	100

3.1.4 Attitudes of personnel in the implementation of medical waste management

Table 6 shows that the majority of nurses (64.7%) have a positive attitude toward medical waste management, while 35.3% have a neutral attitude. None of the nurses exhibit a negative attitude. This suggests that most nurses are supportive and likely to comply with proper medical waste management practices, which is important for maintaining a safe and hygienic healthcare environment. The presence of neutral attitudes, however, indicates an opportunity for further motivation and awareness programs to strengthen commitment across the entire nursing staff.

Table 6. Frequency distribution of nurses' attitudes in medical waste management

No.	Attitudes	Total	Percentage (%)
1.	Positive	11	64.7
2.	Neutral	6	35.3
3.	Negative	-	-
	Total	17	100

3.1.5 Attitudes of waste management staff in the implementation of medical waste management

Table 7 shows that the majority of waste management staff (70%) have a neutral attitude toward medical waste management, while 30% display a negative attitude. None of the staff exhibit a positive attitude. This indicates a concerning lack of strong support or commitment among cleaning service personnel toward proper medical waste handling. The absence of positive attitudes and the presence of negative perceptions may hinder the effectiveness of medical waste management practices. Therefore, targeted interventions—such as training, awareness campaigns, and motivation strategies—are needed to improve their attitudes and ensure safer, more compliant waste handling.

Table 7. Frequency distribution of waste management staff's (cleaning service) attitudes in medical waste management

No.	Attitudes	Total	Percentage (%)
1.	Positive	-	-
2.	Neutral	7	70
3.	Negative	3	30
	Total	10	100

3.1.6 Actions of personnel in the implementation of the medical waste management system

Table 8 indicates that the majority of nurses (70.6%) demonstrate good medical waste management practices, while 29.4% show fair practices. None of the nurses fall into the poor practice category. This suggests that most nurses are implementing medical waste management procedures effectively, contributing to a safer healthcare environment. However, the presence of some staff with only fair practices highlights the need for continued training and monitoring to ensure consistent adherence to proper waste management protocols across all personnel.

Table 8. Frequency distribution of medical waste management practices by nurses

No.	Practices	Total	Percentage (%)
1.	Poor	-	-
2.	Fair	5	29.4
3.	Good	12	70.6
	Total	17	100

3.1.7 Actions of waste management staff (cleaning service) in the implementation of the medical waste management system

Table 9 shows that the majority of waste management staff (80%) exhibit fair practices in medical waste management, while 20% demonstrate poor practices. Notably, none of the staff are categorized as having good practices. This indicates a significant need for improvement in the practical handling of medical waste among cleaning service personnel. The lack of good practices may pose risks to health and safety, both for staff and the surrounding environment. Therefore, targeted training, supervision, and reinforcement of standard procedures are essential to elevate their performance to acceptable and safe levels.

Table 9. Frequency distribution of waste management practices by waste management staff (cleaning service)

No.	Practices	Total	Percentage (%)
1.	Poor	2	20
2.	Fair	8	80
3.	Good	-	-
	Total	10	100

3.1.8 Relationship between personnel's knowledge and the implementation of medical waste management

Table 10 illustrates the relationship between nurses' knowledge levels and their implementation of medical waste management practices. Among those with high knowledge, 9 nurses (out of 10) demonstrated good practices, while only 1 (4.7%) showed fair practices. None exhibited poor practices. Among those with moderate knowledge, 3 nurses (16.5%) showed good practices, and 4 (24.7%) had fair practices. Again, none demonstrated poor practices. No nurses were recorded as having a low level of knowledge. This distribution suggests a positive relationship between higher knowledge and better implementation of medical waste management practices. Nurses with high knowledge tend

to perform better in applying proper procedures, indicating that strengthening knowledge through training and education may significantly improve waste management outcomes.

Table 10. Frequency distribution of the relationship between nurses' knowledge and medical waste management practices

Knowledge	Implementation of Waste Management						Total	Percentage
	Good		Fair		Poor			
	N	%	N	%	N	%		
High	9		1	4.7	-	-	10	58.8
Moderate	3	16.5	4	24.7	-	-	7	41.2
Low	-	-	-	-	-	-	-	-
Total	12	70.6	5	29.4	-	-	17	100

3.1.9 Relationship between waste management staff's (cleaning service) knowledge and the implementation of medical waste management

Table 11 presents the relationship between the knowledge level of waste management staff (cleaning service) and their implementation of medical waste management practices. Among those with moderate knowledge, 5 staff (50%) demonstrated fair practices, and 1 (10%) showed poor practices. Among those with low knowledge, 3 staff (30%) exhibited fair practices, and 1 (10%) demonstrated poor practices. No staff had high knowledge, and none demonstrated good practices across all knowledge levels. This indicates that even among staff with moderate knowledge, good practices are absent, and poor practices still exist. It suggests that knowledge alone may be insufficient to ensure proper medical waste handling among cleaning staff. Therefore, in addition to improving knowledge through training, practical skill development, supervision, and reinforcement of procedures are essential to improve waste management performance in this group.

Table 11. Frequency distribution of the relationship between waste management staff's (cleaning service) knowledge and medical waste management practices

Knowledge	Implementation of Waste Management						Total	Percentage (%)
	Good		Fair		Poor			
	N	%	N	%	N	%		
High	-	-	-	-	-	-	-	-
Moderate	-	-	5	50	1	10	6	60
Low	-	-	3	30	1	10	4	40
Total	-	-	8	80	2	20	10	100

The table shows that among nurses with a positive attitude, 10 (60%) demonstrated good practices, and 1 (4.7%) demonstrated fair practices. Among those with a neutral attitude, 2 nurses (10.6%) showed good practices, and 4 (24.7%) showed fair practices. None of the nurses exhibited a negative attitude, nor were there any poor practices recorded. This suggests a positive correlation between attitudes and practices—nurses with a positive attitude are more likely to engage in good medical waste management practices. Meanwhile, those with a neutral attitude tended to perform less optimally, indicating the importance of strengthening positive attitudes to improve practice quality.

Among the waste management staff, none had a positive attitude. Of those with a neutral attitude, 6 staff (60%) exhibited fair practices and 1 (10%) exhibited poor practices. Among those with a negative attitude, 2 (10%) showed fair practices, and 1 (10%) had poor practices. None demonstrated good practices. This indicates that neutral or negative attitudes are associated with suboptimal or poor waste management practices among cleaning service personnel. The complete absence of positive attitudes and good practices highlights a serious concern and underscores the need for attitude-shaping interventions, such as awareness-building, motivation, and behavioral reinforcement programs, to encourage better compliance and safer waste management behavior in this group.

Table 12. Relationship between attitudes and medical waste management practices among nurses and waste management staff (cleaning service)

Attitudes	Implementation of Waste Management						Total	Percentage (%)
	Good		Fair		Poor			
	N	%	N	%	N	%		
Frequency distribution of the relationship between nurses' attitudes and medical waste management practices								
Positive	10	60	1	4.7	-	-	11	64.7
Neutral	2	10.6	4	24.7	-	-	6	35.3
Negative	-	-	-	-	-	-	-	-
Total	12	70.6	5	29.4	-	-	17	100
Frequency distribution of the relationship between waste management staff's (cleaning service) attitudes and medical waste management practices								
Positive	-	-	-	-	-	-	-	-
Neutral	-	-	6	60	1	10	7	70
Negative	-	-	2	10	1	10	3	30
Total	-	-	8	80	2	20	10	100

Table 12 shows the distribution of medical waste management practices among nurses based on the location of community health centers (urban vs. rural). In urban health centers, 2 nurses (10.6%) demonstrated good practices, while 4 nurses (24.7%) showed fair practices. In contrast, in rural health centers, 9 nurses (54.1%) showed good practices and 2 nurses (10.6%) demonstrated fair practices. None in either group showed poor practices. This indicates that nurses in rural health centers are more likely to implement good medical waste management practices compared to their urban counterparts. Factors such as local policies, training access, or community engagement may contribute to this difference and warrant further investigation.

Table 13. Differences in medical waste management practices between urban and rural community health centers among nurses and waste management staff (cleaning service)

Location	Implementation of Waste Management						Total	Percentage (%)
	Good		Fair		Poor			
	N	%	N	%	N	%		
Distribution of differences in medical waste management practices by nurses between urban and rural community health centers								
Urban	2	10.6	4	24.7	-	-	6	35.3
Rural	9	54.1	2	10.6	-	-	11	64.7
Total	11	64.7	6	35.3	-	-	17	100
Distribution of differences in medical waste management practices by waste management staff (cleaning service) between urban and rural community health center								
Kota	-	-	1	10	1	10	2	20
Desa	-	-	7	70	1	10	8	80
Total	-	-	8	80	2	10	10	100

For waste management staff, the data shows that in urban health centers, 1 staff member (10%) demonstrated fair practices and 1 (10%) exhibited poor practices. In rural centers, 7 staff members (70%) showed fair practices, and 1 (10%) demonstrated poor practices. No staff in either group demonstrated good practices. This suggests that while fair practices are more common in rural areas, both urban and rural centers lack staff with good medical waste management performance. This reflects a critical need for training and supervision improvements for cleaning service staff in both settings, with a slightly better performance level observed in rural areas.

3.2 Discussion

In the implementation of the medical waste management system in Community Health Centers (Puskesmas) in Bulukumba Regency, both in urban and rural areas, the segregation

and collection stages of medical waste are carried out by nursing staff in each medical care unit using designated medical waste bins. Therefore, the medical waste management system has been implemented from the very beginning at the point of waste generation. The stages of medical waste management in Puskesmas in Bulukumba Regency consist of several processes. First, in the segregation stage, effective healthcare waste management begins with the separation and identification of waste. Waste segregation is the responsibility of the waste producer and must be carried out as close as possible to the point of generation.

Next, the collection stage has also been implemented in accordance with the applicable regulations. Puskesmas in Bulukumba Regency have endeavored to collect medical waste based on the prescribed standards. The specified requirements for waste bins are: (1) made of durable, lightweight, rust-resistant, waterproof materials with a smooth inner surface; (2) equipped with a lid that can be easily opened and closed without hand contact; (3) at least one bin available for every room or every 10-meter radius; and (4) every 20 meters in open waiting areas. In addition, (5) each bin must be lined with a plastic bag of a specified color and symbol; (6) the plastic bag must be removed daily or when two-thirds full; and (7) bins used for infectious (yellow bag) and cytotoxic (purple bag) waste must be cleaned and disinfected immediately after being emptied if they are to be reused.

In the on-site transportation stage, medical waste from each generating room is transported to the temporary storage area using a closed, dedicated trolley. The storage duration must comply with tropical climate standards: a maximum of 48 hours during the rainy season and 24 hours during the dry season (Ministry of Health Regulation, 2004). Puskesmas in Bulukumba Regency have strived to provide transportation facilities in accordance with regulations. The requirements for transport equipment are: (1) smooth and waterproof interior surface; (2) easy to clean and dry; (3) easy loading and unloading of waste; (4) trolleys must be washed after use; and (5) no sharp edges that could damage the bags or containers during loading or unloading.

Furthermore, temporary storage has also been carried out based on established standards. Puskesmas in Bulukumba Regency have endeavored to meet the requirements for temporary storage facilities as stipulated. According to WHO (2005), temporary storage areas must: (a) have a solid, impermeable floor with proper drainage; (b) be equipped with a water supply for cleaning purposes; (c) be easily accessible to waste management personnel and waste transport vehicles; (d) have nearby supplies of cleaning equipment, protective clothing, and plastic bags; (e) not be located near food storage areas; and (f) be protected from sunlight and have adequate lighting. In the off-site transportation stage, observational data show that out of seven Puskesmas in Bulukumba Regency, three located in rural areas (42.9%) transport medical waste to disposal sites using ambulances. The off-site transportation stage includes the transfer of waste from temporary storage points to outside the Puskesmas. The medical waste stored in temporary facilities is transported using ambulances. However, the waste is transported alongside other materials without separation compartments, although the vehicle doors can be locked.

Finally, the disposal of medical waste is carried out either independently by the Puskesmas or in cooperation with hospitals and final disposal facilities (TPA) using incinerators. This finding is supported by a study conducted by Putri (2023) on the identification of hazardous medical solid waste distribution from healthcare facilities in South Sulawesi, which states that healthcare facilities without incinerators may process hazardous medical solid waste at facilities that do have incinerators. The incinerators have a capacity of 80 kg, a temperature range of 800–1300 °C, use kerosene as fuel, have a one-hour operating time setting, and operate on 500W/220V power. Sharp medical waste such as syringes, glass slides, and medicine bottles is incinerated at 800–1300 °C, while other medical waste such as cotton, gauze, plasters, and gloves is incinerated at 500–800 °C. Incineration is carried out once a week depending on the volume of medical waste produced.

The characteristics of staff based on age indicate that age is a distinguishing factor in the level of knowledge and maturity of individuals. Age can also influence the knowledge or insight of respondents. Age determination was based on self-reported information during interviews, counting from birth to the most recent birthday. According to Hurlock (1993),

as a person grows older, their thinking and working capabilities become stronger and more mature. Furthermore, the Indonesian Ministry of Health's Occupational Health Center (2006) classifies the working-age population into three categories: children (0–14 years), productive age (15–54 years), and elderly (above 54 years). The study found that most nurses and waste management staff (cleaning services) at Community Health Centers (Puskesmas) in both urban and rural areas fall within the productive age group. In this regard, the age of respondents is closely related to their cognitive maturity and the community's trust in their roles.

Next, based on education level, it was found that many cleaning service staff possess only basic education. This indicates that not all staff have fulfilled the mandatory nine years of basic education as stipulated by the Minister of Education and Culture Decree No. 0306/V/1995. The higher the education level, the greater the knowledge, which affects their performance evaluation (Adhanari, 2005).

Regarding work experience, it was found that longer work tenure can provide staff with valuable knowledge to recognize workplace hazards. Such knowledge contributes to better work behavior, particularly concerning occupational health and safety. Consequently, experienced staff tend to be more cautious and comply with established procedures. Conversely, staff with shorter tenure tend to be less careful due to their limited understanding of workplace risks, increasing their vulnerability to hazards. Furthermore, staff knowledge in medical waste management implementation is a critical aspect that requires attention. Knowledge is the result of sensory processing of an object through the senses, influenced by the intensity of attention and perception. Cognitive knowledge is essential in forming behavior. Actions based on knowledge and awareness tend to be more sustainable than those lacking both.

Regarding staff attitudes, most nursing staff at medical service units in Puskesmas in Bulukumba Regency show positive attitudes toward medical waste management, particularly in the segregation and collection stages. Conversely, most cleaning service staff in Puskesmas in Jember Regency demonstrate a neutral attitude towards overall medical waste management. Attitude is an internal reaction to stimuli and cannot be directly observed but inferred from behavior (Ahmadi, 2007; Azwar, 2003). According to Notoatmodjo (2007), attitude contains emotional responses to social stimuli, which are important in daily life. Concerning staff actions, most nurses perform medical waste management properly, while cleaning service staff perform it adequately. According to Permana (2007), actions are processes through which humans fulfill desires, often motivated by experience and motivation. For example, the urge to maintain a clean environment and prior experience in disposing, collecting, and destroying medical waste are important factors influencing behavior (Kusnoputranto, 1995). Knowledge also serves as a foundational factor determining actions.

The relationship between staff knowledge and medical waste management implementation was examined using Spearman's correlation test, showing a correlation between knowledge and actions. However, this relationship is not always linear, as good knowledge does not always result in appropriate actions. This aligns with La Pona's findings, which state that knowledge does not always form the basis of practice. Thus, high knowledge does not necessarily lead to good behavior or action (Munandar, 2006; Walgito, 2004). Similarly, the relationship between attitude and medical waste management implementation shows a correlation between attitude and staff actions based on Spearman's test. However, a positive attitude does not always translate into proper actions if not supported by adequate facilities. Maimunah (2002) research supports this, stating that effective waste management systems require sufficient infrastructure.

Finally, analysis of differences in medical waste management system implementation between urban and rural Puskesmas shows that most rural Puskesmas better meet the requirements compared to urban ones. Based on the Mann–Whitney test, there is a significant difference between the two regions. Factors influencing this difference include the knowledge, attitude, and actions of nurses and cleaning service staff. In rural Puskesmas, staff generally have higher knowledge and positive attitudes, leading to compliance with

regulations. Conversely, in urban Puskesmas, staff tend to have moderate knowledge and neutral attitudes, resulting in less compliance with medical waste management requirements.

4. Conclusions

Based on the results and discussion of the analysis of the implementation of the medical waste management system, the following conclusions can be drawn: The implementation of medical waste management at community health centers (Puskesmas) in Bulukumba Regency complies with the medical waste management requirements set by the Indonesian Ministry of Health. However, some aspects are not fully met, such as the absence of medical waste logos on medical waste bins in some Puskesmas, not all Puskesmas using medical waste transport equipment like carts or trolleys, and the use of ambulances as transport vehicles for medical waste in some Puskesmas.

Most nurse officers involved in this study were aged 15–54 years, had higher education levels, had worked for ten years or more, were self-employed/entrepreneurs, and the implementation of medical waste management was categorized as good. Most cleaning service staff were aged 15–54 years, had elementary education levels, had worked for ten years or more, and their medical waste management implementation was categorized as fair.

There was a significant correlation between nurses' knowledge and the implementation of medical waste management ($\alpha = 0.037$), as well as between cleaning service staff's knowledge and medical waste management implementation ($\alpha = 0.010$). Additionally, significant correlations were found between nurses' attitudes and medical waste management implementation ($\alpha = 0.010$), and between cleaning service staff's attitudes and medical waste management implementation ($\alpha = 0.035$). Finally, there were significant differences in the implementation of medical waste management by nurses between urban and rural Puskesmas ($\alpha = 0.016$), and differences in implementation by cleaning service staff between urban and rural Puskesmas ($\alpha = 0.036$).

Author Contribution
The author is solely responsible for the entire process of this research and article preparation. The contributions include formulating the research idea, data collection, data analysis, interpretation of the results, writing the manuscript, and final revisions prior to publication.

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