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**Current Practices of Medical Waste Management in Juba
Hospitals, Juba City - South Sudan (2025)**



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Current Practices of Medical Waste Management in Juba Hospitals, Juba City - South Sudan (2025)



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ABSTRACT

Purpose: Effective medical waste management is a critical pillar of public health and environmental safety, particularly in fragile health systems. This study assessed medical waste management programs in hospitals within Juba City, South Sudan.

Methodology: A descriptive cross-sectional design that combined quantitative and qualitative methods. Data were collected from 404 healthcare staff, revealing that while 95.8% were aware of waste types, systemic gaps in segregation and disposal persisted.

Results: 79.2% practiced reported segregation of medical waste at the point of generation, 35.9% relied on black-coded bins for hazardous materials, and 69.6% used incineration as the primary treatment method. Challenges included inadequate transportation systems (60.9%), lack of policy enforcement (37.4%), and insufficient protective equipment. The study concludes that Juba's waste management is hindered by structural fragility and limited institutional memory.

Unique Contribution to Theory, Practice and Policy: The study provides evidence based to policymakers, hospital administrators, and public health authorities for strengthening healthcare waste management policies. The findings can guide the Ministry of Health South Sudan and other stakeholders in designing sustainable environmental health policies aimed at improving healthcare waste management and protecting public health and the environment.

Keywords: *Occupational Safety, Waste Segregation, Medical Waste Management, Healthcare Waste Disposal Practices*

INTRODUCTION

Medical wastes are inherently hazardous, containing infectious agents that pose severe risks to human health and the ecological environment if improperly handled. Global estimates suggest that hospitals generate increasing volumes of waste, with approximately 15% classified as infectious, toxic, or radioactive [1]. While the World Health Organization (WHO) has addressed these issues since the 1980s, the focus has only recently shifted from high-income nations to low-income countries. In these developing contexts, unsafe disposal in landfills and the use of inadequate incinerators remain primary concerns for public health officials [2].

Healthcare institutions function as service-oriented establishments providing diagnostic, therapeutic, and rehabilitative services, yet they are among the largest per capita generators of waste. This waste category encompasses cultures of infectious agents, pathological remains, and sharps such as hypodermic needles and scalpel blades. Furthermore, hazardous materials like chemotherapeutic agents, formaldehydes, and heavy metals such as mercury are frequently used in clinical settings. Consequently, healthcare workers and patients face a high risk of acquiring infections from contaminated environments or needle-stick injuries[3].

The persistence of poor waste management in sub-Saharan Africa is often attributed to inadequate government funding and weak human resource capacity. Gaps in existing policies, standard operating procedures (SOPs), and capacity building for waste handlers represent significant setbacks to operational safety [4]. Training healthcare workers in modern techniques is essential for addressing these risk factors within the medical waste fraternity. Establishing national legislation complemented by technical guidelines is the first step toward achieving proper management in low-income countries like South Sudan [5].

In regional capitals like Dhaka, Bangladesh, rigorous estimations of waste generation have been used to drive scientific policy improvements. South Sudan mirrors these challenges, as it currently lacks specific comprehensive legislation for healthcare waste management despite some related legal frameworks [6]. Existing regulations are often non-specific regarding the definition of hazardous categories and legal obligations for transport and reporting. This lack of specificity leads to a fragmented approach where facilities operate without standardized safety protocols or oversight.

Global data indicate that approximately 16 billion injections are administered annually, many of which are not disposed of properly in least-developed nations [7]. Less than one in three facilities in these regions possesses basic waste management services, leading to hazardous waste being mixed with domestic trash. This trend is alarming because management is often delegated to poorly educated laborers who work without protection. Such practices expose staff and the surrounding community to unnecessary risks, including the spread of blood-borne pathogens [8].

Several studies conducted by Abdulla et al and Dehghani and Azam in Jordan and Iran highlighted a lack of legal provisions and in sufficient treatment facilities[9,10]. The Republic

of South Sudan is no exception to these challenges, facing an array of logistical and regulatory hurdles. As the demand for healthcare services in Juba increases, there is a concurrent rise in the volume of waste generated. An organized system is required to curb occupational hazards and protect the environment from infectious threats [8].

The current system in South Sudan lags behind international standards due to major limitations in handling practices and efficiency. This study represents the first effort in the country to evaluate the impact of waste management interventions. By identifying current practices and risk factors, the research aims to provide policy makers with evidence-based data for regulation. Ultimately, protecting the population requires a shift from accepting waste as a downside of care to proactive avoidance.

METHOD AND MATERIALS

Study Design

This study employed a descriptive cross-sectional design, integrating both quantitative and qualitative methodologies to ensure a comprehensive assessment.

Study Area

The research was conducted in Juba City, the capital of South Sudan and a major administrative and health hub. Juba's tropical climate and rapid urban expansion make it a critical site for examining waste management challenges. The city hosts the highest concentration of health facilities in the country, ranging from national referral hospitals to private clinics.

Study population

The study population consisted of healthcare workers directly involved in waste handling, including doctors, nurses, and environmental health officers. Inclusion criteria required staff to have worked at their respective hospitals for at least six months to ensure institutional knowledge. Administrative staff willing to participate were also included to provide a management perspective on existing policies. Conversely, staff on leave or temporary contractors were excluded to maintain the consistency of the data collected.

Sampling and sample size

A multi-stage sampling technique was utilized to select participants. A total of 404 participants were enrolled, providing a robust dataset for statistical analysis. The sampling ensured that diverse facility types, from surgery-intensive hospitals to laboratory diagnostics centers, were represented.

Data Collection and Analysis

Data collection involved face-to-face interviews using a structured questionnaire that covered specific research objectives. Additionally, key informant interviews and observation checklists were used to triangulate the quantitative findings. The questionnaire included sections on awareness, segregation practices, the use of personal protective equipment, and disposal

methods. Observations allowed researchers to verify whether the reported practices matched the actual operational reality on the hospital floors.

Quantitative data were cleaned, organized, and entered into statistical software for descriptive and inferential analysis. Frequencies and percentages were used to present demographic features and waste management practices.

Ethical Approval

Ethical considerations were strictly observed throughout the research process to protect participant rights. Approval was obtained from the Research Ethics and Review Board (MOH-RERB) Ministry of Health, South Sudan. Participants were informed of the study's objectives and provided written consent before data collection. Confidentiality was maintained through the use of ID codes, and all participants had the right to withdraw at any time.

RESULTS

The response rate for the study was 95.8% 404 out of 422 participants

Table 1: Study response rate

Response	Frequency	Percent
Unreturned	404	95.8%
Returned	18	4.2%
Total	422	100%

The socio-demographic profile of the participants showed a male majority (56.2%) and a youthful workforce, with 48.8% aged 18-30 years. Educational levels were relatively high, with 61.4% having attained tertiary education. However, institutional experience was limited; 34.7% had worked in their facility for less than one year. Table 2 summarizes these key characteristics.

Table 2: Socio-demographic Features of the Participants

Variable	Category	Frequency (n)	Percentage (%)
Gender	Male	227	56.2%
	Female	177	43.8%
Age	18–30 years	197	48.8%
	30–40 years	111	27.5%
Education	Tertiary	248	61.4%
	Secondary	115	28.5%
Experience	< 1 year	140	34.7%
	> 6 years	132	32.7%

The awareness of staff regarding the types of medical waste generated revealed that 95.8% claimed awareness, there was confusion regarding specific items; 71.0% correctly identified expired drugs, but 71.0% also incorrectly considered food waste as medical waste. Regarding

segregation, 79.2% reported doing so at the point of generation, but the use of non-standard black-coded bins (35.9%) was more common than yellow (27.7%) or red (24.8%) bins. Table 3 provides a breakdown of these practices.

Table 3: Current Practices in Medical Waste Management

Variable	Response	Frequency (N)	Percentage (%)
Aware of waste types	Yes	387	95.8%
Segregated at source	Yes	320	79.2%
PPE used	Always	337	83.4%
Bins used	Black	145	35.9%
	Yellow	112	27.7%
Waste collection	Daily	269	66.6%

The evaluation of management strategies revealed that 71.0% of hospitals had a written policy, but adherence was inconsistent. Common strategies included sharps safety boxes (82.7%) and color-coded bins (70.3%), though 73.0% did not maintain waste logs. Treatment methods were dominated by incineration (69.6%), while 38.1% of facilities reported using open burning as a disposal method. Table 4 outlines the institutional frameworks and treatment methods found in the study.

Table 4: Institutional Management and Treatment Methods

Variable	Response	(N)	(%)
Written Policy	Yes	287	71.0%
SOPs for Disposal	Yes	308	76.2%
Incineration Used	Yes	281	69.6%
Open Burning Used	Yes	154	38.1%
Audit/Inspection	Yes	184	45.5%

Respondents identified several structural barriers hindering effective management within their facilities. Lack of adequate personal protective equipment was cited by 31.4% of participants as a major challenge. Furthermore, 60.9% pointed to inadequate transportation and disposal systems as a primary cause of waste accumulation. Other identified challenges included poor supervision (46.5%) and a lack of policy enforcement (37.4%), which often led to lapsed safety protocols.

Regarding personal protective equipment (PPE), although 83.4% claimed to "always" wear it, specific item usage varied significantly. Gloves were the most commonly used (93.8%),

followed by masks (79.2%), while goggles were only used by 30.7% of the staff. This discrepancy suggests that while basic protection is prioritized, more comprehensive safety gear is often neglected or unavailable. These results indicate a clear need for standardized supply chains and better safety culture.

Staff recommendations for improvement focused heavily on training and resource allocation. Nearly all participants emphasized the need for regular education to keep pace with evolving waste management standards. They also suggested that increased government funding for specialized transportation and PPE supplies would drastically reduce disease transmission risks. Improving the frequency of garbage collection was another dominant theme mentioned by respondents to prevent bin overflows.

In summary, the results highlight a workforce that is knowledgeable but constrained by systemic failures. High awareness of waste types does not translate into standardized practices because of equipment shortages and weak oversight. The reliance on high-risk methods like open burning further underscores the lack of advanced infrastructure. These findings provide a clear roadmap for necessary interventions in Juba's healthcare system.

DISCUSSION

The presence of a tertiary-educated workforce in Juba hospitals reflects a critical foundation for effective healthcare waste management, as education enhances comprehension of environmental safety standards and improves the cognitive ability required for hazard identification and proper waste segregation. Empirical evidence indicates that higher levels of education are strongly associated with improved knowledge, attitudes, and practices in waste handling among healthcare workers [11]. However, educational attainment alone is insufficient to guarantee compliance with safe practices in the absence of institutional support systems. Debere et al. argue that knowledge does not always translate into practice when organizational structures, supervision, and enforcement mechanisms are weak [12]. In Juba, the limited institutional tenure of healthcare workers may further constrain the application of acquired knowledge, thereby weakening the consistency of safe waste management practices.

The youthful demographic composition of Juba's healthcare workforce presents both opportunities and risks in the adoption of improved waste management practices. Younger healthcare workers are often more adaptable and open to innovation, particularly in the implementation of digital monitoring systems and modern segregation techniques [5]. This adaptability can be instrumental in advancing sustainable waste management practices in low-resource settings. However, risk behavior studies suggest that less experienced workers may exhibit higher tendencies toward unsafe practices due to limited exposure and situational judgment (Nowak et al., 2020). Furthermore, gender dynamics may influence compliance levels, as male-dominated roles have been associated with lower adherence to safety protocols. This duality underscores the necessity for structured mentorship and supervision systems to ensure that innovation receptivity does not compromise occupational safety.

Persistent deficiencies in waste segregation and material availability significantly undermine the effectiveness of hospital waste management systems in Juba. Proper segregation at the point of generation is widely recognized as the cornerstone of infection prevention and environmental protection [13]. Studies in comparable contexts have demonstrated that inconsistent supply of color-coded bins and inadequate infrastructure directly reduce compliance among healthcare workers [8]. Nevertheless, material shortages alone cannot fully explain systemic failures. Similar study conducted by Quttainah and Singh emphasize that leadership commitment and organizational prioritization play decisive roles in ensuring effective waste management systems [3]. In Juba, the observed segregation gaps therefore reflect a combination of infrastructural inadequacies and managerial inefficiencies, highlighting the need for integrated interventions.

The reliance on incineration as the primary waste disposal method in Juba hospitals reflects a pragmatic approach commonly adopted in resource-constrained settings. Incineration is effective in reducing infectious waste volume and destroying pathogens, making it a widely endorsed method for immediate risk mitigation [14]. However, environmental concerns associated with low-temperature incineration, including the release of toxic emissions such as dioxins and furans, have been extensively documented [15]. While some scholars defend small-scale incineration as a necessary interim solution in fragile contexts lacking advanced technologies, others advocate for a transition toward non-burn technologies to enhance environmental sustainability [16]. In Juba, this tension illustrates the broader governance challenge of balancing immediate feasibility with long-term environmental and public health considerations.

Systemic logistical deficiencies, including weak transportation networks and limited waste collection infrastructure, represent significant barriers to effective healthcare waste management in Juba. These structural challenges are characteristic of fragile governance contexts, where resource constraints and institutional instability hinder service delivery [17]. Access to reliable waste management services has been identified as a key determinant of safe waste handling practices in healthcare facilities [7]. However, an exclusive focus on systemic weaknesses may overlook the potential for localized improvements. Tesfaye et al. highlight that facility-level leadership and innovation can drive meaningful progress even within constrained environments [18]. Therefore, Juba's challenges reflect a complex interplay between macro-level structural deficits and underutilized micro-level managerial potential.

The availability and consistent use of personal protective equipment (PPE) are critical components of occupational safety in healthcare waste management. Adequate PPE supply has been shown to enhance worker confidence and improve compliance with safety protocols [19]. Furthermore, access to protective gear is directly linked to reduced exposure to infectious hazards among waste handlers [2, 20]. However, PPE availability alone does not ensure utilization. Behavioral studies indicate that compliance is strongly influenced by workplace culture, training, and supervision. In addition, procurement inefficiencies and resource

misallocation in fragile states can further exacerbate supply challenges. In Juba, the interplay between material scarcity and weak enforcement mechanisms highlights the need for both resource provision and behavioral reinforcement strategies.

Governance and regulatory frameworks play a fundamental role in shaping healthcare waste management systems. Effective policies provide the foundation for standardization, accountability, and enforcement of safe practices [21]. However, the lack of specificity and enforceability in existing regulations in South Sudan creates ambiguity that undermines institutional accountability. While national guidelines are essential, evidence suggests that facility-level protocols and internal monitoring mechanisms are equally critical for ensuring daily compliance [22]. Moreover, without external oversight, policies risk remaining symbolic rather than operational [23]. In the context of Juba, achieving effective waste management requires a balanced approach that integrates top-down regulatory reforms with bottom-up institutional strengthening.

CONCLUSION

The current study carried out to assess current practices of medical waste management in Juba city hospitals, South Sudan. The findings demonstrate that healthcare waste management in Juba is shaped by a multifaceted interaction of educational capacity, workforce demographics, infrastructural limitations, and governance challenges. While the presence of an educated and youthful workforce presents opportunities for improvement, systemic deficiencies in material availability, logistics, and regulatory enforcement continue to hinder effective practice. The reliance on incineration further reflects the tension between immediate practicality and long-term sustainability. Addressing these challenges requires an integrated approach that combines capacity building, resource provision, institutional leadership, and policy reform.

RECOMMENDATIONS

To improve healthcare waste management in Juba Hospitals, continuous professional training programs should be implemented to reinforce the practical application of knowledge among healthcare workers and the government should revise and enforce regulatory frameworks to ensure accountability.

CONFLICT OF INTEREST DECLARATION

The authors declare that they have no conflict of interest.

CONTRIBUTIONS OF THE AUTHORS

The authors contributed in study design, data collection, analysis, and interpretation of the findings. The author also prepared the manuscript, reviewed relevant literature, and finalized the report for publication.

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