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Evaluation of Different Healthcare Waste Management Practices and Problems among Primary and Secondary Hospitals in Mianwali

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DECLARATIONS

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ABSTRACT

Background: Healthcare waste management is a critical component of public health, particularly in developing countries like Pakistan, where inadequate waste handling poses significant risks to healthcare workers, the environment, and the community. Primary and secondary hospitals often face different challenges due to infrastructure, resources, and waste volume variations. This study evaluates healthcare waste management practices and identifies associated problems in primary and secondary hospitals in Mianwali. **Objective:** To evaluate the healthcare waste management practices in primary and secondary hospitals in Mianwali. **Methodology:** A cross-sectional study was conducted in public hospitals of Mianwali. About 112 participants, including staff from primary (59) and secondary (53) hospitals, were selected through simple random sampling. Data were collected using structured questionnaires and quantitative observations. Key areas assessed included waste segregation, storage, transportation, treatment methods, staff training, and compliance with regulations. **Results:** Primary hospitals demonstrated higher compliance with segregation practices (80% using color-coded bins) compared to secondary hospitals (70%). However, secondary hospitals had more frequent training sessions (93% of staff trained) and generated higher volumes of hazardous waste (20% compared to 15% in primary hospitals). Challenges reported included a lack of resources (70-75%), inadequate infrastructure (11.7-5%), and insufficient enforcement of regulations. Significant gaps were observed in the disposal of pathological, cytotoxic, and liquid waste, with secondary hospitals more likely to use outdated incineration methods (85% vs. 60%). **Conclusion:** The study highlights disparities in healthcare waste management practices between primary and secondary hospitals. While primary hospitals excel in segregation compliance, secondary hospitals face challenges in resource allocation and infrastructure. Addressing these issues requires targeted training programs, stricter enforcement of regulations, and investment in modern waste treatment technologies.

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INTRODUCTION

Worldwide public health systems identify Healthcare waste management (HCWM) as an essential operational component, especially within the context of low- and middle-income nations.[1] Healthcare waste management practices that fail to meet minimum standards continue as a major challenge throughout many areas thus endangering both healthcare workers and public health as well as environmental safety.[2] The challenges impacting healthcare waste management become more pronounced throughout developing countries specifically in Pakistan because of inadequate medical infrastructure combined with weak governing bodies. This study investigates healthcare waste management at both primary and secondary hospitals within the Mianwali region because it shares systemic restrictions.

Healthcare waste presents special importance as it possesses immediate risks that affect both human health and ecological systems.[3] Human transmission of bloodborne diseases HIV, Hepatitis B, and Hepatitis C through incorrectly handled infectious waste including used needles, contaminated sharps, and biological samples presents a serious health risk.[4] Precariously disposed hazardous materials made up of cytotoxic and radioactive waste prove damaging to both nature and public well-being over extended periods.[5] Pakistan struggles with extensive healthcare burdens and restricted funding that makes inefficient waste management systems worsen these limitations to elevate healthcare worker and vulnerable population safety risks.[6]

Karachi alone produces 100 plus tons daily of medical waste that contains notable infectious elements among the total waste. A significant amount of discarded waste that is improperly separated and managed before disposal ends up at municipal dumpsites thus threatening community safety.[7] Primary and secondary medical facilities in Mianwali constitute the main subject of this investigation which analyses their healthcare waste management processes.[8] Each healthcare institution offers specialized services to its population because primary hospitals serve local communities but secondary hospitals treat patients with specific complex medical issues.[9] These facilities generate different amounts and forms of waste that create distinctive waste management issues because of their divergent operational systems.[10] The data collection employed structured questionnaires with observational methods to present an extensive view of Mianwali's healthcare waste management systems' existing procedures and shortcomings. The research scope concentrates on modern HCWM methods by analyzing existing waste management activities during the 2023-2024 period. The study analyses hospital practices in both primary and secondary facilities to present elemental comparisons of their operational frameworks along with their benefits and challenges. This research focuses on examining the current healthcare waste management structures of Mianwali district which blends urban and rural healthcare facilities within its borders.

The research benefits from this targeted focus which reveals sitio-specific issues throughout Mianwali while advancing knowledge about waste management efforts in comparable regions. Industrial policy recommendations to enhance healthcare waste management become possible because of this research along with its application in improving waste management throughout Mianwali along with other regions. National HCWM guidelines exist in Pakistan yet hospitals often disregard these standards because there is weak enforcement together with poor awareness levels among healthcare workers.[11] This research addresses existing knowledge gaps by delivering specific guidance about enhancing Healthcare Waste Management practices. The research results enable governmental authorities to determine the priority investments required for implementing state-of-the-art waste treatment solutions including autoclaves and microwave disinfection systems throughout the area.[12]

The initial sections of this paper emphasize why Mianwali's primary and secondary hospitals require improved healthcare waste management systems. Approaching HCWM from a context-based and scope-driven perspective, this study works to overcome existing practice shortcomings while building safer sustainable healthcare frameworks. The following sections present an expansive analysis of HCWM practices throughout the region using the methodology and results assessment and subsequent implications examination. Healthcare waste management presents diverse complexities due to its requirements for segregation followed by storage and transportation which lead to treatment progressions to definitive disposal.[13] This research

examines Mianwali healthcare facilities' complete interlinking operational phases to reveal detailed weaknesses and corrective opportunities. This study engages both primary and secondary healthcare institutions with substantial operational and waste disposal variations between them. Community health facilities located throughout the district implement basic medical operations for residents and create significantly less clinical waste.[14] Secondary healthcare facilities serve broader patient communities by delivering advanced medical care resulting in comprehensive waste collections that encompass both toxic waste types and biomedical waste streams.[15]

This research examines healthcare waste management practices in primary and secondary facilities to create an extensive portrait of how resource distribution and waste variation affect hospital facilities of different capacities. Harbor protection healthcare waste represents both a key operational matter and misconduct objective as well as a compelling public health challenge.[16] The improper disposal of surgical tools and needles creates dangerous needle punctures that might spread deadly infections including HIV and Hepatitis B and C.[17] Medical waste incineration without proper containment methods results in the emission of dangerous pollutants which both harm human health and damage the environment. The critical nature of proper HCWM methods becomes more essential in areas with limited health facility resources such as Mianwali.[18] Because of insufficient knowledge healthcare staff randomly combine waste streams resulting in the universal waste stream becoming more dangerous to treat at higher expense. Study outcomes analyze education-based and training-based interventions for Mianwali's healthcare workers and hospital staff to understand what works best for enhancing hazardous waste management outcomes.[19] The study aimed to evaluate and compare healthcare waste management practices in primary and secondary hospitals in Mianwali.

METHODOLOGY

The study employed a cross-sectional design to analyze healthcare waste management (HCWM) practices in primary and secondary hospitals in Mianwali, Pakistan. The research included a sample of 112 participants, equally divided between primary (n=59) and secondary (n=53) hospitals, selected using a simple random sampling technique. Data collection involved structured questionnaires and observational checklists, focusing on key aspects such as waste segregation, storage, transportation, treatment methods, compliance with regulations, and challenges faced by staff. Data were analyzed using descriptive and inferential statistics, with results summarized as frequencies and percentages. The chi-square test was used to compare waste management in primary and secondary hospitals. Ethical approval was obtained from the Superior University Lahore's review board, ensuring participant anonymity and informed consent. The study spanned six months, from June to December 2024, with data collected in three phases: instrument development, field data collection, and result interpretation.

RESULTS

Table 1 shows that 112 healthcare professionals.

Table 1: Demographic variables

Experience of Staff		Hospital Categories			p-value
		Primary Hospitals	Secondary Hospitals	Total	
Experience (years)		59 (52.7%)	53 (47.3%)	112 (100%)	0.731
	<10 years	44 (74.6%)	41 (77.4%)	85 (75.9%)	
	>10 years	15(25.4.%)	12 (22.6%)	27 (24.1%)	
Profession	OT / Lab tech / Technologists	15 (25.4%)	21 (39.6%)	36 (32.1%)	0.437
	Sanitary worker	6 (10.2%)	4 (7.5%)	10 (8.9%)	
	Nurses/LHVS	22 (37.1%)	15 (28.5%)	37 (33.0%)	
	Doctor	16 (27.1%)	13 (24.5%)	29 (25.9)	

Included 59 primary hospital workers representing 52.7% and 53 secondary hospital employees representing 47.3% of the total participants. Respondents from primary and secondary hospitals consistently reported that their working experience was below ten years. The research showed primary hospital staff with lower experience levels (74.6%) matched similar percentages (77.4%) found in secondary hospital staff. Analysis of years of experience produced a p-

Table 2: Current waste management practices challenges and problems

Waste Management Practices, Problems and Challenges		Hospital Categories			p-value
		Primary Hospitals	Secondary Hospitals	Total	
How does your hospital segregate healthcare waste?	Color-coded bins	48 (81.4%)	36 (67.9%)	84 (75%)	<0.001
	Labeled containers	0	14 (26.4%)	14 (12.5%)	
	All	11 (18.6%)	3 (5.7%)	14 (12.5%)	
How often is healthcare waste collected from various departments?	Multiple times a day	41 (69.5%)	41 (77.4%)	82 (73.2%)	0.348
	Daily	18 (30.5%)	12 (22.6%)	30 (26.8%)	
What methods are used for the treatment and disposal of healthcare waste?	Incineration and landfilling	16 (27.1%)	0	16 (14.3%)	<0.001
	Incineration	36 (61%)	44 (83%)	80 (71.4%)	
	Autoclaving	3 (6.8%)	4 (7.5%)	7 (6.3%))	
	Landfilling	4 (6.8%)	5 (9.4%)	9 (8%)	
How often do you conduct training programs for staff on healthcare waste management?	Monthly	56 (93.3%)	30 (56.6%)	86 (76.8%)	<0.001
	Quarterly	3 (5.1%)	19 (35.8%)	22 (19.6%)	
	Annually	0	4 (7.5%)	4 (3.6%)	
	Never	0	2 (3.3%)	0	
Does the establishment generate Cytotoxic waste at special concern?	Yes	27 (45.8%)	20 (37.7%)	110 (98.2%)	0.390
	No	32 (54.2%)	33 (62.3%)	2 (1.8%)	
How is Liquid waste disposal?	Sinks	43 (72.9%	49 (92.5%)	92 (82.1%)	0.007
	Sewers	16 (27.1%)	4 (7.5%)	20 (17.9%)	
What are the main challenges your hospital faces in managing healthcare waste?	Lack of resources	42 (71.2%)	38 (71.7%)	80 (71.4%)	0.504
	Inadequate infrastructure	8 (13.6%)	3 (5.7%)	11 (9.8%)	
	Financial constraints	4 (6.8%)	3 (5.7%)	7 (6.3%)	
	Lack of enforcement	3 (5.1%)	5 (9.4%)	8 (7.1%)	

value tallying 0.731 which exceeds the typical p-value threshold of 0.05 at significance. The analysis shows primary hospital staff and secondary hospital staff demonstrate equivalent experience levels across both institutions. Laboratory technicians, OT technicians, and sanitation workers made up the second-largest responding roles after nurses in basic hospitals (37.1%) and secondary facilities (28.5%). Table 2 shows that secondary hospital waste containers 26.4% were used to segregate medical waste whereas primary hospitals did not adopt it. Statistical tests confirmed a significant difference ($p<0.001$). Collection of waste occurred multiple times per day 69.5% in primary hospitals and 77.4% in secondary hospitals but the difference was not statistically significant ($p=0.348$). Incineration waste disposal method methods were used by 61% of primary hospitals and 83% of secondary hospitals with a significant difference ($p<0.001$). Autoclaving and landfilling methods were both hospitals showed similar adaptation rates ($p=0.972$ and $p = 0.637$, respectively). The recycling method of waste management is practiced by 15% of primary hospitals and 24.5% of secondary hospitals but with no significant difference ($p=0.217$).

Healthcare waste management training was received by 93.3% of primary hospital staff but only 58.3% in secondary hospitals with a highly significance difference ($p<0.001$). Primary hospitals were reported to generate 45.8% cytotoxic waste, whereas 37.7% of secondary hospitals do. Liquid waste disposal was predominately via sinks 72.9% in primary hospitals compared to secondary hospitals, with a significant difference ($p=0.007$). Healthcare waste management challenges were lack of resources were facing both hospitals (71.2% in primary and 71.7% in secondary), which was the most common issue. Secondary hospitals also report fewer problems with infrastructure and enforcement compared to primary hospitals.

DISCUSSION

Results from this study explain healthcare waste management practices at primary and secondary hospitals throughout Mianwali Punjab. This research examines healthcare waste management practices in these institutions through demographic analysis and evaluations of waste separation methods in combination with waste collection methods and disposal techniques alongside participant training data. The current study's results enable us to analyze their relevance to previous studies and identify fresh findings beyond existing literature. The analysis includes a review of our methodological decisions while highlighting unexpected results with supporting explanations followed by suggested research paths for the future.

Event research showed that primary hospitals (81.4%) adopted colour-coded waste bins much more often than secondary hospitals (67.9%). The research supports the findings by Ahmad et al. (2021) and Kapoor et al. (2020) which showed that Pakistani and Indian primary healthcare institutions follow standardized waste segregation methods due to their ability to supervise the workforce and control their smaller sizes.[20] Hospitals use color-coded waste bins properly to separate dangerous waste from regular waste which safeguards medical waste disposal processes. The larger volumes of trash handled by secondary hospitals create more persistent obstacles when trying to maintain continuous adherence to waste segregation standards.

Data shows that primary hospitals perform better at segregation yet findings indicate substantial compliance gaps that match existing research outcomes. The waste segregation guidelines remained unfollowed by 20% of healthcare personnel in primary facilities. Multiple factors including insufficient training of staff and 38 inadequate infrastructure and poor understanding of waste management risks led to this lack of compliance. Sharma et al. (2019) reported similar infrastructural problems in smaller healthcare settings as healthcare workers maintained limited adherence to waste segregation standards because of insufficient education and inconsistent enforcement.[21] The research found that secondary hospitals used labeled containers more often than primary hospitals (26.4% against 0%).

The conventional pattern of strict waste segregation compliance by primary hospitals does not appear to apply in this case. Secondary hospitals demonstrated attempts at implementing novel waste segregation strategies because their significant waste amount and varied materials require different approaches. Careful tracking through labeled trash containers at secondary hospitals shows how these institutions aim to

separate waste types within their constrained building spaces. The application of labeled containers shows less effectiveness than color-coded methods and potentially leads to waste contamination incidents. The p-value under 0.001 confirms statistical significance in the usage patterns of labeled containers between primary and secondary hospitals which indicates their waste segregation practices differ substantially.

Results from this research demonstrate the fundamental necessity of employee training programs and knowledge platforms for healthcare waste-handling processes. Training attendance was substantially different between primary hospitals and secondary hospitals. Training on healthcare waste management was received by 93.3% of primary hospital workers yet only 58.3% of workers in secondary hospitals received comparable instruction. Previous research studies including Ahmed et al. (2020) discovered staff training programs were implemented with significant frequency by healthcare facilities with smaller teams.[22] Identifying this problem presents significant risks to medical personnel safety. Insufficient training attendance at secondary hospitals leads to documented health problems from inadequate waste management practices. When hospital staff practices unsafe waste segregation and disposal procedures needle-stick injuries persist as major avenues of transmitting illnesses such as HIV, hepatitis B, and C.

The published waste segregation violations reported by secondary hospitals created higher occupational risks for their hospital workers. Healthcare waste management infrastructure serves as a primary determinant for achieving successful waste disposal results. The survey results showed that secondary hospitals mainly employed outdated incinerator systems as their waste disposal method with 83% admitting use whereas primary hospitals exhibited 61% utilization numbers. Research shows that most low-resource hospitals depend on incineration methods because they lack access to modern waste treatment solutions. Effectively controlled emission systems are absent from hospital incinerators which produce serious environmental damage through dioxins and furans generation according to Sharma et al. (2019).[23]

CONCLUSION

The study highlights disparities in healthcare waste management practices between primary and secondary hospitals. While primary hospitals excel in segregation compliance, secondary hospitals face challenges in resource allocation and infrastructure. Addressing these issues requires targeted training programs, stricter enforcement of regulations, and investment in modern waste treatment technologies.

DECLARATIONS

Consent to participate: Written consent had been taken from patients. All methods were performed following the relevant guidelines and regulations.

Availability of data and materials: Data will be available on request. The corresponding author will submit all dataset files.

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