The Role of Healthcare Workers in Safe Medical Waste Segregation: A Narrative Review

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Abstract
Safe medical waste segregation depends on the everyday decisions of healthcare workers at the point of generation. Although most healthcare waste is non-hazardous, poor segregation can mix general waste with infectious, sharps, pharmaceutical, chemical and other hazardous materials, increasing occupational risk, treatment costs and environmental harm. This narrative review synthesizes evidence on the role of physicians, nurses, laboratory staff, waste handlers, cleaners and support workers in safe medical waste segregation. Published studies and authoritative guidance were reviewed with emphasis on knowledge, attitudes and practices, training interventions, colour-coded segregation systems, sharps management, supervision, infrastructure barriers and links with infection prevention. The reviewed evidence indicates that knowledge alone does not ensure safe practice. Compliance improves when training is practical, repeated, role-specific and reinforced by visible containers, clear labels, adequate personal protective equipment, routine audits and feedback. A recurring gap is the limited inclusion of cleaning and waste-handling staff in structured training, despite their high exposure during collection and internal transport. Safe segregation should therefore be treated as a shared infection-control and occupational-safety responsibility rather than a housekeeping task. Hospitals should integrate waste segregation into orientation, continuing education, ward-level audits and safety indicators.

Keywords: medical waste, healthcare workers, waste segregation, infection control, occupational safety, training, sharps management

Introduction

Medical waste is generated during diagnosis, treatment, immunization, laboratory testing, blood collection, surgical care, pharmaceutical services and other health-related activities. International guidance commonly distinguishes between general non-hazardous waste and hazardous categories such as infectious waste, sharps, pathological waste, pharmaceutical waste, chemical waste and radioactive waste. The World Health Organization estimates that approximately 85% of waste generated by healthcare activities is comparable to domestic waste, while the remaining 15% is hazardous and requires special handling, storage, transportation and treatment (World Health Organization, 2024). This relatively small hazardous fraction can create disproportionate risk when it is not separated early and accurately.

Waste segregation is therefore the first and most important control point in the medical waste management chain. Once hazardous waste is mixed with general waste, the entire stream may require more expensive treatment and handling. Conversely, when segregation is correct at the point of generation, healthcare facilities can reduce infection risk, lower treatment costs and limit unnecessary incineration or chemical treatment. In practical terms, segregation is not only a technical procedure; it is a repeated human behaviour performed under time pressure in wards, procedure rooms, emergency departments, laboratories, vaccination areas and operating theatres.

Healthcare workers are central to this process because they make the first decision about where an item is placed. Doctors and nurses generate much of the clinical waste during procedures, laboratory staff handle specimens and contaminated materials, pharmacists may handle expired or unused medicines, and cleaners or waste handlers move bags and sharps containers through internal transport routes. Each group has different tasks, risks and training needs. For this reason, safe segregation cannot be achieved by instructing only one professional group. It requires a coordinated institutional system in which all staff understand their roles and have the tools needed to perform them.

The consequences of poor segregation are well documented. Incorrect disposal of sharps increases the risk of needlestick injuries and bloodborne infection. Mixing infectious waste with general waste can expose cleaners, waste handlers and

downstream workers to pathogens. Poorly separated pharmaceutical and chemical waste may contribute to environmental contamination, while inadequate storage and transportation can increase the risk of spills, odour, pests and community exposure. Recent guidance has also placed greater attention on pharmaceutical waste and antimicrobial resistance because unsafe disposal of medicines, antibiotics and contaminated liquids can add to environmental drivers of resistance (World Health Organization, 2025a; World Health Organization, 2025b).

The issue is especially important in low- and middle-income settings, where healthcare facilities may face inconsistent supply of colour-coded bins, limited personal protective equipment, insufficient storage areas and weak supervision. However, gaps are not limited to resource-constrained settings. Even where written policies exist, compliance may remain inconsistent if training is not reinforced, if bins are poorly located, if staff are rushed, or if cleaning and support staff are excluded from formal education. This review therefore examines medical waste segregation through the role of healthcare workers and the institutional conditions that enable or weaken safe practice.

Materials and Methods

This review paper was prepared as a structured narrative review of published studies and authoritative guidance concerning the role of healthcare workers in safe medical waste segregation. The review focused on evidence related to knowledge, attitudes and practices; colour-coded segregation; sharps disposal; training interventions; audit and feedback systems; occupational safety; and barriers affecting compliance in healthcare facilities.

Sources were identified from peer-reviewed articles and official documents issued by organizations such as the World Health Organization, the Centers for Disease Control and Prevention, WHO/UNICEF Joint Monitoring Programme, and national health authorities. Priority was given to literature published from 2015 onward, while older sources were retained when they provided foundational evidence on training, cost reduction or policy implementation. Studies were considered relevant when they addressed healthcare workers, waste handlers, cleaners, nurses, physicians, laboratory workers or hospital support staff in relation to healthcare waste segregation or management.

The review included cross-sectional knowledge-attitude-practice studies, qualitative studies, quasi-experimental training studies, systematic reviews, meta-analyses and institutional audits. Evidence was synthesized narratively rather than statistically because the reviewed studies used different settings, professional groups, instruments, definitions and outcome measures. The Results section summarizes recurring findings without conducting a new pooled estimate. The Discussion interprets these findings in relation to infection prevention, occupational safety, training design and practical hospital management.

Results

Healthcare workers as the first control point

The reviewed literature consistently identifies the point of generation as the decisive stage for safe segregation. CDC training materials emphasize that safe waste management is the responsibility of all staff involved in patient care and facility operations, not only cleaning personnel (Centers for Disease Control and Prevention, 2023). The same principle appears in national and institutional waste policies, including Saudi guidance that requires sorting, packaging and labelling in the location where waste is generated before internal transport (Ministry of Health, Saudi Arabia, 2022).

The practical implication is that waste segregation depends on routine decisions made immediately after a clinical task. A syringe, blood-stained dressing, laboratory culture plate, empty medicine vial or non-contaminated packaging item may appear small, but the decision about its disposal pathway determines the risk level, cost and treatment requirement for the entire waste stream. For this reason, workers who generate waste must be trained before mistakes are passed to downstream staff.

Knowledge, attitudes and practice patterns

Knowledge-attitude-practice studies show that positive attitudes do not always translate into correct segregation behaviour. In primary healthcare centres in Hail, Saudi Arabia, Reddy and Al Shammari (2017) reported that 54.8% of participants had good knowledge, 48.9% had favourable attitudes and 49.6% had good practices. A later study in northern Saudi Arabia found that 47.1% of healthcare workers had high knowledge and 49.5% had high practice scores, while positive attitudes were higher at 65.1% (Thirunavukkarasu et al., 2022). These findings suggest a gap between willingness to comply and the practical ability or opportunity to do so.

This pattern is not unique to Saudi Arabia. Studies from South Africa, Botswana, Nigeria, Uganda, Zambia and Lesotho report variable levels of knowledge and practice, often with differences between professional groups (Olaifa, Govender and Ross, 2018; Mugabi, Hattingh and Chima, 2018; Wafula, Musiime and Oporia, 2019; Leonard et al., 2022; Siimane and Ntsihlele, 2024; Amaike et al., 2025). Across these studies, previous training, professional role, years of experience, education level, availability of guidelines and access to waste management materials were frequently associated with better practice.

A systematic review and meta-analysis of healthcare waste management practice in Sub-Saharan Africa found that good practice was achieved by only about half of healthcare workers, with training, knowledge and the use of manuals or guidelines associated with better outcomes (Berihun et al., 2025). The importance of this result is that it moves the discussion beyond individual awareness and toward the conditions that make good practice possible.

Training and behaviour change

Training emerged as one of the most consistent modifiable factors. Quasi-experimental studies indicate that structured training can improve knowledge, attitudes and practices when it is practical and reinforced over time. Kumar, Somrongthong and Shaikh (2015) reported improvement after intensive healthcare waste management training in Pakistani teaching hospitals. Follow-up work showed that behaviour change may differ by professional category, with doctors, nurses and paramedical staff responding differently over time (Kumar, Somrongthong and Ahmed, 2016).

In Egypt, Khashaba, El-Gilany and Denewar (2023) found improved knowledge, attitudes and practices among nurses and housekeepers after a waste management intervention. In Tunisia, Bannour et al. (2024) reported that an educational intervention improved several practice indicators, including segregation of sharps and segregation of soft and solid waste. More recent evidence from a dental setting also suggests that role-specific training can improve knowledge and practice among healthcare professionals (Gao et al., 2025).

The common lesson is that a single lecture is unlikely to be enough. Effective interventions tend to combine explanation of waste categories with demonstrations, visible reminders, ward-level feedback and repeat assessment. Training is strongest when it is specific to the task performed by each group: nurses need bedside and injection-related segregation; physicians need procedure-related disposal and medication-related awareness; laboratory staff need specimen and culture-related safety; cleaners and waste handlers need bag closure, labelling, lifting, spill response, route safety and sharps-container precautions.

Segregation systems, sharps and infrastructure

The presence of clear physical systems is another repeated finding. Colour-coded bins, puncture-resistant sharps containers, readable labels, trolleys for internal transport and appropriate personal protective equipment are not secondary details; they are enabling conditions for compliance. When containers are missing, poorly located, overfilled or inconsistent with national rules, even knowledgeable staff may dispose of waste incorrectly.

Sharps management deserves special emphasis because sharps injuries can occur at the point of use, during collection, during transport or during final handling. CDC guidance recommends that sharps containers be available in every care area, placed within reach at the time of injection or procedure, and not filled beyond safe capacity (Centers for Disease Control and Prevention, 2023). This protects both clinical workers and downstream staff who may otherwise encounter exposed needles in bags or general waste.

WHO/UNICEF data on WASH in healthcare facilities indicate that basic waste management services remain uneven globally, particularly in fragile and resource-constrained settings (WHO/UNICEF Joint Monitoring Programme, 2024). Where facilities lack basic segregation supplies or regular waste collection, training alone cannot produce consistent safe practice. Safe segregation therefore requires both behaviour change and supply reliability.

Barriers reported in the literature

Across the reviewed studies, barriers were not limited to knowledge deficits. The most common barriers were organizational and practical: inadequate training, shortage of colour-coded containers, unclear labelling, weak supervision, insufficient personal protective equipment, high workload, poor inclusion of cleaners and waste handlers in training, and limited monitoring. Qualitative work from Saudi Arabia and Ethiopia has emphasized that staff often describe training as general, insufficiently practical or disconnected from daily workflow (Alshagrawi and Alahmari, 2025; Berhe et al., 2025).

Table 1. Practical synthesis of recurring findings on healthcare workers and waste segregation

Evidence domain	Recurring finding	Practical implication
Knowledge and attitudes	Awareness and positive attitudes are often higher than correct practice.	Assessment should include observed or audited practice, not only questionnaires.
Training	Training improves practice when it is repeated, practical and role-specific.	Annual lectures should be supplemented by ward demonstrations and refresher sessions.
Sharps management	Needlestick risk persists when sharps containers are absent, distant or overfilled.	Sharps containers should be available at the point of use and monitored for safe fill levels.
Cleaners and waste handlers	Support staff may be highly exposed but less included in structured training.	Training equity is necessary for occupational safety and continuity of the waste chain.
Infrastructure	Lack of bins, labels, PPE and transport tools weakens compliance.	Waste management supplies should be treated as core infection-control materials.
Audit and feedback	Compliance improves when errors are measured and discussed regularly.	Simple monthly indicators can identify repeated mistakes and guide targeted retraining.

Infection control and occupational safety

Safe segregation has direct infection-control value. When waste is placed in the correct container at the point of generation, infectious items can be handled using the correct precautions, sharps can be isolated from bags, and contaminated materials can be treated without unnecessary exposure. Poor segregation, by contrast, shifts risk from clinical staff to cleaners, waste handlers, transport workers and external disposal workers.

The occupational-safety dimension is especially important because the most exposed workers may have the least authority in the healthcare hierarchy. Studies repeatedly show that cleaning and waste-handling staff require the same seriousness of

training and protective equipment as clinical staff. Excluding them from training creates a weak link in the waste management chain and can undermine the efforts of clinicians who segregate waste correctly at the bedside.

Discussion

The evidence indicates that safe medical waste segregation is best understood as a shared system of practice rather than a simple compliance rule. Written policies are necessary, but they do not automatically change behaviour. Safe practice occurs when workers know the rule, believe it is important, have the correct container nearby, have enough time to use it, see supervisors modelling and reinforcing the rule, and receive feedback when errors occur.

One implication is that hospitals should shift from general awareness campaigns to role-specific training. A generic session may introduce waste categories, but it cannot address the different decisions made by a surgeon, nurse, laboratory technician, pharmacist, cleaner or internal transport worker. Training should therefore be tailored to job tasks. For example, nurses need practical emphasis on injections, dressings, bedside bins and sharps containers; laboratory staff need specimen and culture disposal pathways; pharmacists need pharmaceutical waste procedures; cleaners need bag handling, spill response, route safety and personal protective equipment.

A second implication is that segregation cannot be separated from infrastructure. Many studies describe staff who know the correct procedure but cannot comply because bins are missing, colour codes are inconsistent, sharps containers are full, or protective equipment is unavailable. This means that training outcomes should not be judged only by worker behaviour. Facility managers must also ensure uninterrupted supplies, readable labels, safe storage areas and transport routes. Waste segregation materials should be treated as core patient-safety and infection-control supplies, not as optional housekeeping items.

A third implication concerns supervision and feedback. Staff behaviour is more likely to persist when compliance is measured regularly and when results are returned to the wards in a constructive way. Simple indicators can be useful: proportion of correctly labelled bags, overfilled sharps containers, hazardous items found in general waste, general items found in hazardous waste, availability of colour-coded bins, number of needlestick incidents and number of staff trained. These indicators can help convert waste management from an invisible support process into a visible quality-improvement activity.

The review also highlights the importance of training equity. Cleaners, waste handlers and porters are frequently exposed during bag collection, container replacement, internal transport and storage, yet they may receive shorter or less formal training than clinical professionals. This is both a safety gap and an ethical issue. A facility that trains clinicians but neglects support staff cannot claim to have a complete segregation system, because the waste chain continues after the bedside decision.

Cost is another important reason to improve segregation. When general waste is thrown into infectious-waste bags, hospitals pay for unnecessary hazardous-waste treatment. Previous work has shown that improved segregation can reduce costs by decreasing the amount of waste requiring special handling (Johnson et al., 2013; Vaccari, Tudor and Perteghella, 2018). This does not mean that cost should override safety. Rather, it means that safety and cost control can align when segregation is accurate.

Medical waste segregation is also connected to broader environmental and antimicrobial-resistance concerns. Incorrect pharmaceutical waste disposal can contribute to environmental contamination and may support antimicrobial-resistance pressures when antibiotics and contaminated liquids enter wastewater or landfill pathways (World Health Organization, 2025a; World Health Organization, 2025b). Healthcare workers should therefore understand that segregation is not only about colour-coded bins. It is also part of environmental protection, medicine stewardship and public health security.

This review has limitations. It is a narrative review rather than a formal systematic review, and the included studies vary in country, facility level, sample size, professional group and measurement tool. Many studies rely on self-reported practices, which may overestimate compliance. Nevertheless, the evidence is consistent in showing that good segregation requires a combination of knowledge, practical training, available supplies, supervision, audits and inclusion of all workers who handle waste.

Conclusion

Safe medical waste segregation begins with healthcare workers, but it is sustained by the institution. The reviewed evidence shows that physicians, nurses, laboratory staff, pharmacists, cleaners, waste handlers and support workers all contribute to the safety of the waste management chain. Knowledge is important, yet it is not enough when bins are absent, labels are unclear, sharps containers are overfilled, training is generic or supervision is weak.

Hospitals should adopt an integrated approach built on six practical elements: mandatory orientation for all staff groups, role-specific refresher training, reliable availability of colour-coded containers and sharps boxes, consistent use of labelling and personal protective equipment, routine audit with feedback, and inclusion of waste indicators in infection prevention and occupational safety programmes. In resource-constrained settings, these elements may be introduced gradually, but the priority should remain the same: correct segregation at the point of generation.

Ultimately, medical waste segregation should not be viewed as a housekeeping detail. It is a clinical safety practice, an occupational-safety requirement, a cost-control opportunity and an environmental responsibility. When healthcare workers are trained, equipped and supported, safe segregation becomes a routine part of quality care.

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