Sharps Waste and Needlestick Injuries in Healthcare Settings

Aminah Rahil N Almatrafi[1], Khalid Mohammed Alzahrani[2], Emad Abdullah Alrasheed[3], Turki Abdullah Jarrah[4], Wael Yousef Almaili[5], Thamer Awad Almutairi[6], Mohammed Saad Aldoaibi[7], Fares Mohammed Alabdullah[8], Osama Ali Alsallami[9], Mohammad Fahad Alqahtani[10], Sulaiman Muhayl Almutairi[11]

[1]National Guard Health Affairs, Alahsa, Saudi Arabia; almatrafiam1@mngha.med.sa
[2]Medical Imaging Department, National Guard Health Affairs, Saudi Arabia; Alzahranikh14@mngha.med.sa
[3]Medical Imaging Department, National Guard Health Affairs, Saudi Arabia; alrasheedem2@mngha.med.sa
[4]Medical Imaging Department, National Guard Health Affairs, Saudi Arabia; JarrahTu@mngha.med.sa
[5]Medical Imaging Department, National Guard Health Affairs, Saudi Arabia; Mailiw@mngha.med.sa
[6]Medical Imaging, National Guard Health Affairs, Saudi Arabia; ALMUTAIRITH1@mngha.med.sa
[7]Nuclear Medicine and Molecular Imaging, National Guard Health Affairs, Saudi Arabia; Albishimo@mngha.med.sa
[8]National Guard Health Affairs, Riyadh, Saudi Arabia; Zxfareszx@hotmail.com
[9]National Guard Health Affairs, Jeddah, Saudi Arabia; ossoma97@gmail.com
[10]National Guard Health Affairs, Riyadh, Saudi Arabia; mohammedf.q64@gmail.com
[11]National Guard Health Affairs, Riyadh, Saudi Arabia; ALMUTAIRISU9@mngha.med.sa

Abstract

Sharps waste is generated wherever needles, lancets, scalpels, suture needles, guidewires, broken glass or other skin-penetrating devices are used. Its management is inseparable from the prevention of needlestick and other sharps injuries because risk persists from the moment a device is handled until the closed container is treated and finally disposed of. This narrative review examines the epidemiology and circumstances of sharps injuries, the contribution of waste-management practices, and the effectiveness of preventive measures in healthcare settings. A focused search of peer-reviewed studies and authoritative guidance published from 1990 to June 2026 was undertaken, with emphasis on surveillance data, Saudi Arabian evidence, intervention studies and current occupational-exposure guidance. Reported injury patterns varied by setting and method of ascertainment, while underreporting was consistently substantial. Nurses, physicians, trainees, surgical personnel, phlebotomy staff and waste handlers faced distinct hazards. Injuries occurred during procedures, recapping, transfer of instruments, disposal, and contact with overfilled or incorrectly segregated containers. Evidence supported a layered prevention strategy combining elimination of unnecessary injections, safety-engineered devices, point-of-use puncture-resistant containers, standardized work practices, training, surveillance and prompt post-exposure management. Device introduction alone was less reliable when activation was difficult or workflow was unchanged. Healthcare organizations should treat sharps safety as a continuous clinical-and-waste pathway, supported by procurement, infection prevention, occupational health and environmental services.

Keywords: sharps waste, needlestick injuries, occupational exposure, healthcare workers, safety-engineered devices, waste management

1. Introduction

Sharps are indispensable in modern healthcare, yet their clinical utility creates an occupational hazard that continues after the procedure has ended. The category includes hollow-bore needles, lancets, suture needles, scalpels, trocars, guidewires, pins, broken ampoules and other items capable of cutting or puncturing skin. Once used, these objects may carry blood or other potentially infectious material. The same item therefore moves through two safety domains: it is first a clinical device and then a hazardous waste object. Separating these domains in policy or training leaves predictable gaps at the moment of disposal and during subsequent handling.

The consequences of a percutaneous injury extend beyond the puncture itself. Exposure assessment, source testing, baseline and follow-up laboratory investigations, hepatitis B prophylaxis when indicated, and rapid consideration of human immunodeficiency virus (HIV) post-exposure prophylaxis may be required. Anxiety can persist during follow-up even when transmission is unlikely. Hepatitis C virus (HCV) transmission after percutaneous exposure is uncommon but documented; current guidance estimates an average risk of approximately 0.2% following exposure to anti-HCV-positive blood (Moorman et al., 2020). Historical estimates for HIV and hepatitis B virus (HBV) demonstrate why source status, injury depth, inoculum and worker immunity remain clinically important (Centers for Disease Control and Prevention, 2001).

Sharps injuries are also a measurement problem. Routine incident reports identify patterns within an institution but miss events that are never reported. Survey studies often capture additional injuries, although recall and selection bias can inflate or distort rates. Denominators differ across publications: injuries per worker, occupied bed, procedure, device purchased or device used are not interchangeable. Despite these limitations, surveillance repeatedly identifies procedural handling, surgery, recapping, delayed disposal, unsafe passing of instruments and waste-container failures as recurring circumstances.

Waste management determines who remains at risk after the original user releases the device. A correctly selected container placed within arm's reach can end the exposure pathway immediately. An overfilled, unstable or poorly located container can instead transfer the hazard to another clinician, cleaner, porter, waste handler or contractor. The World Health Organization (WHO) estimates that most healthcare waste is non-hazardous, but the smaller hazardous fraction requires reliable segregation to protect workers and the environment (World Health Organization, 2024). Saudi regulations define sharps waste broadly and require segregation into designated containers at the point of generation, closure at the marked limit or no more than three-quarters full, labelling and controlled internal transport (Ministry of Health, Saudi Arabia, 2019).

This review aims to: (1) describe the burden and circumstances of needlestick and sharps injuries; (2) examine how segregation, container use and downstream waste handling influence injury risk; (3) summarize evidence for engineering, work-practice and organizational controls; and (4) identify practical priorities for healthcare institutions, with attention to the Saudi healthcare context.

Materials and Methods

A focused narrative review was conducted to integrate evidence on sharps waste management and occupational needlestick or sharps injuries. Searches covered January 1990 to June 2026 and used PubMed-indexed literature, publisher databases, institutional surveillance reports, and official documents from WHO, the United States Centers for Disease Control and Prevention (CDC), the Occupational Safety and Health Administration (OSHA), the Exposure Prevention Information Network (EPINet), and the Saudi Ministry of Health. Search terms were used alone and in combination: "needlestick injury", "sharps injury", "percutaneous exposure", "sharps waste", "sharps container", "medical waste", "healthcare worker", "safety-engineered device", "underreporting", "Saudi Arabia", "waste handler" and "post-exposure management".

Eligible sources addressed occupational sharps injuries in healthcare, sharps disposal or segregation, safety-device interventions, injury surveillance, post-exposure management, or healthcare-waste regulation. Studies involving hospital, ambulatory, laboratory, dental, imaging, surgical and waste-handling environments were considered. Community-discarded needles were excluded unless the findings directly clarified healthcare-waste handling. Preference was given to original observational or intervention studies, national surveillance datasets, and authoritative technical guidance. Reviews were used to locate seminal studies and to frame areas where direct comparisons were difficult, but primary reports were prioritized for numerical findings.

Titles and abstracts were screened for direct relevance. Full texts or detailed indexed records were then examined for study design, setting, population, injury definition, denominator, major findings and stated limitations. Because designs and denominators were heterogeneous, statistical pooling was not undertaken. Findings were synthesized narratively under four domains: epidemiology, circumstances and affected groups, waste-system contributors, and preventive interventions. Particular attention was paid to whether an intervention addressed the hierarchy of controls and whether reported reductions could be separated from changes in reporting behaviour.

This work used published and publicly available material and involved no human participants or identifiable data; ethical approval was therefore not required. The narrative method was selected to connect clinical device use with the complete waste pathway rather than to estimate a single pooled prevalence.

Results

Burden and distribution of injuries

The 2024 EPINet report included 1,945 sharp-object injury records from 39 participating hospitals, corresponding to 36.0 injuries per 100 average daily census. Among records with occupational category data, nurses accounted for 39.7%, attending physicians 17.5%, physicians in training 12.3%, and surgery attendants 11.1%. Operating and recovery rooms accounted for 43.8% of injuries with a recorded location, followed by patient rooms or wards at 26.5%. Suture needles and disposable syringes were the most frequently recorded devices, at 23.6% and 21.9%, respectively (International Safety Center, 2025).

Saudi studies produced different estimates because their populations and methods varied. In a national cross-sectional survey of 361 healthcare workers, 22.2% reported at least one injury in the preceding year; physicians had the highest reported proportion, followed by nurses, dentists and medical technologists (Abalkhail et al., 2022). A survey of 609 workers in nine hospitals in Jazan reported an overall injury frequency of 24%, with 30% in secondary hospitals and 14% in tertiary hospitals (Makeen et al., 2022). In southern Saudi Arabia, a multicentre study reported an incidence of 11.57% and found higher occurrence in secondary than tertiary hospitals and among surgical staff (Alsabaani et al., 2022). A Jeddah nursing study reported a prevalence of 19.7% (Alharazi et al., 2022).
Underreporting was present across multiple settings. In the national Saudi survey, 53.8% of injury events were not

formally reported (Abalkhail et al., 2022). A 2025 tertiary-hospital study in Saudi Arabia also found substantial underreporting, particularly outside nursing, and identified perceived low risk and reporting-system barriers among the determinants (El-Saed et al., 2025).

Circumstances, devices and affected workers

EPINet data showed that 53.8% of recorded injuries occurred during use of the item, 8.1% between steps of a multi-step procedure, 7.5% after use but before disposal, 5.1% during recapping, and 2.1% while placing an item into a disposal container. Additional disposal-related events involved protruding items, inappropriate waste bags or devices left on work surfaces. Of injuries in which contamination was recorded, 91.0% involved a contaminated sharp; visible blood was noted in 74.5% of those records (International Safety Center, 2025).

Occupational patterns differed by task. Hollow-bore needles predominated in medication administration, phlebotomy and vascular access, whereas suture needles and scalpels were prominent in operating rooms. Trainees and workers early in their careers were represented in survey studies, while environmental services and waste staff were more often injured after the original user had released the item. In the EPINet subset with user information, 23.7% of injured workers were not the original user of the sharp (International Safety Center, 2025).

Sharps waste and system-level findings

Official guidance consistently specified segregation at the point of generation into puncture-resistant, leak-resistant and closable containers. The Saudi implementing regulations required dedicated sharps containers, direct responsibility of the waste producer for segregation, closure at the fill line or no more than three-quarters capacity, labelling, trained internal transport and protective equipment for waste workers (Ministry of Health, Saudi Arabia, 2019). WHO guidance similarly described immediate disposal and closure before containers become overfilled (World Health Organization, 2014).

Qualitative interviews with healthcare professionals in Riyadh identified inconsistent knowledge, insufficient or irregular training, variable access to supplies, workload, weak monitoring and limited organizational support as barriers to biomedical waste management. Participants described leadership support, clear policy, accessible resources and repeated practical education as facilitators (Alshagrawi and Alahmari, 2025). Earlier Saudi work also documented variation in healthcare workers' knowledge of waste categories and management steps (Almohaimeed, 2005).

Prevention and intervention findings

Prospective and quasi-experimental studies generally found reductions after safety-engineered devices were introduced, although effects differed by device and implementation method. Adams and Elliott (2006) observed a decline in reported needlestick injuries after a programme combining safety devices with awareness measures, with device-specific performance varying. In 32 French hospitals, Lamontagne et al. (2007) found lower injury rates with safety-engineered devices and showed that passive or semi-automatic features provided greater protection than devices dependent on user activation. Valls et al. (2007) reported a 93% relative reduction in percutaneous injuries in areas using selected safety devices. A randomized trial of three needleless intravenous systems found differences in injury outcomes across systems, supporting evaluation of specific products rather than treating all safety technologies as equivalent (L'Ecuyer et al., 1996).

The 2024 EPINet dataset recorded a safety design in 20.1% of relevant devices, no safety design in 75.0%, and unknown status in 4.9%. Among safety devices with activation data, the mechanism was fully activated in 6.3%, partially activated in 29.8% and not activated in 63.9% (International Safety Center, 2025).

Table 1. Summary of selected findings

Source	Location	Main result
Abalkhail et al. (2022)	Saudi Arabia	22.2% had an injury; more than half were not reported.
Makeen et al. (2022)	Jazan	Injuries were more common in secondary hospitals.
Alsabaani et al. (2022)	Abha	11.57% had an injury; surgical staff were at higher risk.
EPINet (2024 data)	39 hospitals	Most injuries occurred during device use; nurses were the largest group.
Adams and Elliott (2006)	United Kingdom	Safety devices and awareness measures reduced injuries.
Valls et al. (2007)	Spain	Safety devices produced a marked reduction in injuries.
Alshagrawi and Alahmari (2025)	Riyadh	Training, supplies and leadership improved waste practice.

Discussion

The literature shows that sharps injury prevention cannot be reduced to a reminder to "be careful". Injuries occur within a sequence of design and workflow decisions: whether a sharp is necessary, which device is purchased, where

the procedure is performed, how the item is passed or activated, where the container is positioned, when it is closed, and how it is transported. The persistence of injuries during use and the presence of events after disposal demonstrate that clinical safety and waste management are parts of the same control system.

Interpreting injury estimates

Rates across studies should be compared cautiously. A survey asking whether a worker sustained any injury in the previous year measures a different outcome from an incident-reporting system normalized by occupied beds. Survey estimates are affected by recall and participation, whereas surveillance systems are affected by willingness and ease of reporting. The Saudi estimates ranging from approximately 11% to 24% are therefore not necessarily contradictory. They describe different institutions, staff groups and measurement approaches. More important than a single national percentage is the repeated signal that injuries remain common and that a large fraction is not formally recorded.

Underreporting weakens both individual care and organizational learning. A worker who does not report may miss timely risk assessment, baseline testing, HBV management or HIV post-exposure prophylaxis. At the institutional level, unreported events conceal device failures, problematic locations and unsafe tasks. Reporting processes should be brief, non-punitive and available at all hours. The initial clinical response must not be delayed by a lengthy administrative form. Occupational health teams can complete the epidemiological record after immediate care begins.

Applying the hierarchy of controls

The hierarchy of controls provides a practical order for prevention. Elimination begins with avoiding unnecessary injections, needles and manual steps. Substitution and engineering controls include needleless access, protected blades, blunt suture needles where clinically appropriate, retracting or shielding needles, and containers that resist puncture and cannot be reopened easily. Administrative measures include staffing, competency assessment, no-recapping rules, safe instrument passing, reporting systems and audits. Personal protective equipment is important but is the least reliable barrier against a sharp object; ordinary gloves may reduce the amount of blood transferred but do not reliably prevent penetration.

Safety-engineered devices are most effective when protection is integral to the device and activates automatically or with a simple, one-handed action. The low activation proportions in EPINet records illustrate the limitation of technology that depends on an extra step after a stressful or complex procedure. Selection should therefore include simulated-use testing by nurses, physicians, phlebotomists, technologists and other intended users. Procurement decisions based only on unit price can transfer cost to occupational health, laboratory testing, post-exposure medication, staff absence and psychological distress. A product should be judged by its performance in the actual task, not by the presence of a “safety” label.

Surgical environments require a distinct approach. The large operating-room share in recent EPINet data reflects exposure to suture needles, scalpels, wires and other solid sharps for which conventional needleless systems offer little protection. Neutral zones for passing instruments, verbal announcement of sharp transfer, blunt-tip suture needles for suitable tissue, hands-free techniques, double gloving, adequate lighting and deliberate control during closure address this pattern. These practices work best when included in the operative checklist and reinforced by senior clinicians.

Designing the sharps waste pathway

The safest disposal action is immediate, point-of-use placement of an intact device into a correctly located container. Containers should be visible, upright, stable, within easy reach, and positioned so that users can see the opening. They should not require workers to carry an exposed sharp across the room or reach over a patient. Container openings must accommodate the devices generated in that area without forcing, disassembly or hand entry. Wall-mounted units need adjustment for the users and the clinical environment; a height that is safe for a standing adult may be unsuitable in a seated procedure room or pediatric area.

Fill limits are a safety control, not a housekeeping preference. Closing a container at the manufacturer’s line or before three-quarters capacity prevents protrusion and reduces forceful insertion. Replacement stock should be available before a full unit is removed. Workers should never push contents down, retrieve an item by hand, shake a container to make space, or transfer sharps between containers. Reusable sharps-container systems may reduce material consumption when they are mechanically emptied and processed under controlled conditions, but manual emptying at facility level creates unacceptable exposure.

Segregation errors expand the exposed workforce. A needle placed in ordinary waste can injure a cleaner who reasonably handles the bag as non-sharps material. Conversely, routine waste placed in a sharps container increases cost and accelerates filling. Audits should therefore examine both directions of error. Waste handlers need hepatitis B immunization, task-specific training, heavy-duty protective equipment appropriate to transport, accessible incident reporting, and authority to reject leaking, unlabelled or overfilled containers.

Surveillance, response and learning

A mature programme uses surveillance for prevention rather than for counting alone. Each report should capture occupation, department, device, procedure, timing, original user, safety feature and activation status, container involvement, injury depth, source status and immediate response. Denominators based on devices used or procedures performed permit more meaningful comparison than raw counts. Monthly review by infection prevention, occupational health, nursing, surgery, procurement, environmental services and waste management can identify clusters and assign corrective actions.

Post-exposure management should be treated as an emergency pathway. The wound should be washed without aggressive squeezing; mucous membranes should be irrigated. The exposure and source should be assessed promptly, baseline tests obtained, and indicated prophylaxis initiated without waiting for avoidable administrative steps. Current United States guidance recommends rapid initiation of HIV prophylaxis when indicated and follow-up evaluation, while HCV guidance emphasizes early baseline and follow-up testing because routine HCV post-exposure prophylaxis is not recommended (Kofman et al., 2025; Moorman et al., 2020). Local policies should align with national requirements and available specialist advice.

Implications for Saudi healthcare settings

Saudi healthcare organizations already operate within a regulatory framework that specifies segregation, container closure, labelling, internal transport and worker protection. The remaining challenge is reliable execution across departments, shifts and facility levels. The higher injury proportions reported in some secondary hospitals may reflect differences in staffing, device access, training, reporting and occupational-health infrastructure. Standardization across a health system can reduce these gaps: approved product lists, minimum container specifications, common reporting fields, centralized review and shared training can coexist with local adaptation to department workflow.

Medical imaging, interventional radiology, nuclear medicine and procedural services deserve explicit inclusion. These areas use needles, vascular-access devices, biopsy systems, guidewires, glass vials and radiopharmaceutical components. Some waste may require classification by both sharps and radioactive characteristics. Staff should not improvise between competing waste streams; written procedures must state the container, shielding, decay-storage and final disposal route for each device type. Collaboration among radiation safety, infection prevention and waste management is necessary to avoid solving one hazard while creating another.

Implementation priorities

A practical institutional programme can be organized around six linked priorities. First, map the complete pathway from device selection to final treatment and identify every handoff. Second, remove unnecessary sharps and evaluate safety-engineered alternatives with end users. Third, place standardized containers at the point of use and replace them before the fill limit. Fourth, train and assess workers using the procedures and devices they actually handle. Fifth, maintain a rapid, non-punitive exposure-response service and a surveillance dataset with useful denominators. Sixth, review incidents and near misses through a multidisciplinary committee that has authority over procurement and workflow.

Education remains necessary, but repeated lectures alone are unlikely to sustain improvement. Short simulation, observation of disposal practice, feedback from audits and discussion of recent local incidents are more directly connected to behaviour. Training should include temporary staff, students, contractors and environmental-services workers. Competency should be reassessed when a device changes, after an incident cluster, and at intervals determined by risk.

Limitations

This narrative review did not use meta-analysis, and the search was not designed to produce an exhaustive systematic inventory. Study definitions, recall periods and denominators were heterogeneous. Many publications relied on self-report or passive surveillance, both of which are affected by underreporting. Intervention studies often combined devices, education and policy changes, making the independent effect of each component difficult to isolate. Evidence on downstream waste handlers and on sharps with dual hazards, including radioactive contamination, was less developed than evidence concerning nurses and physicians. These limitations restrict direct numerical comparison but do not alter the consistent need for layered controls across the sharps lifecycle.

Conclusion

Sharps waste and needlestick injuries are one continuous occupational-safety problem. The risk begins during device use and continues through segregation, container closure, internal transport, treatment and final disposal. Surveillance identifies substantial injury burdens, persistent underreporting and important differences by task and setting. Safety-engineered devices can reduce injuries, particularly when activation is passive or intuitive, but technology must be supported by safe workflow, point-of-use containers, timely replacement, worker training, incident reporting and rapid post-exposure care. Healthcare institutions should measure performance across the entire pathway and involve clinical staff, occupational health, infection prevention, procurement, environmental services and waste teams in prevention. In Saudi settings, consistent implementation of existing waste regulations and system-wide standardization offer immediate opportunities to reduce both clinical and disposal-related injuries.

Declarations

Funding: This review received no specific grant from any funding agency in the public, commercial or not-for-profit sectors.

Conflict of interest: The authors declare no conflict of interest.

Ethical approval: Not required because this article is a narrative review of published and publicly available information.

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