A Study to Evaluate the Effectiveness of Structured Teaching on Knowledge and Practice of Safe Handling of Chemotherapy Drugs Among Staff Nurses of Selected Oncology Hospitals

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Abstract

Background: Antineoplastic and other hazardous drugs are essential to modern cancer care, but their toxicity may also create occupational risks for nurses and other healthcare workers. Exposure can occur during receipt, transport, preparation, administration, disposal, handling of contaminated materials, cleaning, and management of spills. Knowledge alone does not guarantee safe practice because personal protective equipment (PPE), engineering controls, staffing, workload, local procedures, and leadership influence what happens at the bedside. Structured teaching may strengthen competence when it is aligned with observed practice and supported by appropriate resources (Connor and McDiarmid, 2006; NIOSH, 2023; Siegel et al., 2024).

Aim: To review evidence on safe handling of chemotherapy drugs and present a practical framework for evaluating whether a structured teaching programme improves staff nurses' knowledge and observed practice in selected oncology hospitals. The proposed objectives are to measure baseline knowledge and practice, deliver a standardised teaching programme, compare pre-intervention and post-intervention scores, assess retention, and identify workplace factors associated with safe practice.

Methods: A narrative review approach was used to synthesise current professional standards, occupational-safety guidance, and empirical studies of nursing education and hazardous-drug exposure. The proposed evaluation uses a quasi-experimental pre-test/post-test design. A structured knowledge questionnaire and an observation checklist should be developed from current guidelines, reviewed by experts, piloted for clarity, and tested for reliability. Analysis should report descriptive statistics, paired comparisons, effect sizes, confidence intervals, and associations between training exposure and performance.

Expected contribution: The framework links classroom teaching with demonstration, return-demonstration, competency assessment, feedback, and refresher education. Since the protocol has not been implemented in the selected hospitals, effectiveness must be established by collecting and analysing actual data. The review supports structured education as one component of a wider occupational-safety programme, not a substitute for engineering controls, suitable PPE, clear procedures, or management accountability.

Keywords: chemotherapy; hazardous drugs; cytotoxic drugs; staff nurses; structured teaching programme; knowledge; safe handling; occupational exposure; oncology nursing; quasi-experimental study.

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Introduction

Chemotherapy remains an important treatment modality for many malignancies, although its place in care now sits alongside immunotherapy, targeted therapy, endocrine treatment, radiation therapy, surgery, and supportive approaches. Antineoplastic drugs differ in mechanism, formulation, and toxicity, but some can harm healthy cells and may pose occupational risks when workers are exposed outside a therapeutic context. Staff nurses routinely participate in medication verification, patient assessment, administration, monitoring, documentation, management of body-fluid precautions, and disposal of contaminated items. Their actions influence both treatment safety and the protection of colleagues, patients, family caregivers, environmental services staff, and waste

handlers (International Society of Oncology Pharmacy Practitioners [ISOPP], 2022; Siegel et al., 2024).

Hazardous-drug safety is not limited to the moment an infusion is connected. The medication pathway begins with procurement and receipt, continues through storage, pharmacy preparation, transport, administration, line disconnection, patient excreta handling, cleaning, and final waste disposal. Contamination may be present on drug-vial exteriors and equipment before a nurse begins a task. Surface and hand sampling studies show that exposure opportunities may extend beyond the staff who directly prepare or administer medication (Hon et al., 2013; Hon et al., 2014). A nurse may follow a single procedure correctly yet remain exposed if downstream disposal, cleaning, or handling of shared surfaces is unsafe.

Effective safe handling is therefore a systems responsibility. Staff must understand the hazards and perform tasks competently, while hospitals must ensure that appropriate equipment, PPE, written procedures, spill kits, training time, and occupational-health arrangements are accessible. The National Institute for Occupational Safety and Health (NIOSH) updated its list of hazardous drugs for healthcare settings in its 2024 list, published as NIOSH publication 2025-103, and recommends setting-specific assessment when selecting exposure controls (NIOSH, 2024/2025; NIOSH, 2023). A teaching programme should use the current institutional hazardous-drug list and local standard operating procedures rather than relying on an old or generic list.

A structured teaching programme provides a consistent method to address gaps that may arise from differences in initial education, clinical exposure, informal learning, and recall of safety instructions. It may include short didactic sessions, visual materials, practical demonstrations, simulated spill response, PPE practice, scenario discussion, and a competency check. A meaningful evaluation should assess more than recall. Nurses should demonstrate that they can choose suitable precautions, handle infusion equipment safely, segregate waste correctly, respond to a spill, and report an exposure. The present manuscript reviews the rationale for these activities and outlines a feasible study framework for selected oncology hospitals.

Background and Statement of the Problem

The potential harms associated with occupational exposure to antineoplastic drugs have been recognised for decades. Depending on the agent, dose, route, frequency, duration, and individual susceptibility, exposure may involve skin irritation, acute toxic effects, reproductive or developmental harm, genotoxic effects, or potential carcinogenic risk. Evidence from biomonitoring and environmental sampling has demonstrated contamination in some healthcare workplaces despite the presence of protective procedures. This does not mean that every exposed worker will develop disease; it means that exposure should be prevented as far as reasonably practicable and that precautions should be consistent with the hazard (Connor and McDiarmid, 2006; Connor et al., 2010; Fransman et al., 2007).

Nurses may understand that chemotherapy is hazardous but still omit a step when gloves are unavailable, a spill kit is difficult to locate, staffing is inadequate, or a task is considered routine. Such barriers indicate a gap between knowledge and behaviour. Polovich and Martin (2011) reported that glove use was more common than gown use in their survey of oncology nurses and that some respondents lacked awareness of national safe-handling guidance. The study is not a current estimate for every hospital, but it illustrates why training should include observed performance and an assessment of supply and workflow barriers rather than assume that a lecture alone will change practice.

Evidence from educational studies suggests that targeted programmes can improve knowledge and, in some settings, observed performance. (Nouri et al., 2021) reported improvement in knowledge and performance after standard-guideline education in a small quasi-experimental study. (Sreekumaran et al., 2025) also found a statistically significant improvement in post-intervention knowledge among nursing personnel following a programme on safe chemotherapy administration. In contrast, (Saker et al., 2026) reported improved knowledge but no statistically significant short-term change in self-reported practice or attitudes after a single educational intervention. Together, these findings suggest that teaching is useful but that transfer to daily practice needs additional reinforcement and organisational support.

The practical problem addressed by the proposed study is whether a well-planned and standardised teaching package can improve nurses' knowledge and safe-handling practices in selected oncology hospitals. The study must establish what nurses know before teaching, what behaviours are demonstrated during routine care, and whether any improvement remains after the immediate post-test. Local results could help educators select refresher topics, support competency-based authorisation, improve compliance audits, and guide administrators in allocating supplies and training resources.

Need and Significance of the Study

The clinical value of the study is prevention. Safe handling protects nurses and support staff while promoting more reliable medication processes for patients receiving high-risk treatment. A structured programme can make critical steps explicit and consistent across shifts, wards, and levels of experience. It may also help identify where low practice scores result from missing equipment, poorly designed work areas, unclear policies, or impractical procedures rather than individual knowledge deficits alone. Such findings support a fair safety culture that treats near misses and exposure events as opportunities for improvement instead of reasons to conceal problems.

The educational significance is that teaching effectiveness can be examined at several levels: learning, demonstrated competence, workplace behaviour, and sustained performance. Immediate knowledge gains may fade over time; a one-time session may not affect habits under pressure. Follow-up measurement, simulation, coaching, and feedback can identify whether nurses transfer learning

into actual tasks. This approach aligns with professional standards that emphasise training, competency verification, documentation, and continuing education for personnel whose roles involve antineoplastic agents (ISOPP, 2022; Oncology Nursing Society [ONS], 2024).

The administrative significance is the potential to convert evidence into standard operating procedures and measurable quality indicators. A hospital can track the proportion of staff who have completed training, observed compliance with task-specific PPE, availability of spill kits, completion of exposure reports, and time from incident recognition to occupational-health evaluation. An educational intervention should be paired with procurement and workflow review because it is unreasonable to expect consistent practice when staff lack approved gloves, gowns, eye protection, disposal containers, or clear procedures.

Aim, Objectives, Research Questions and Hypotheses

Aim

To evaluate the effectiveness of a structured teaching programme on knowledge and practice of safe handling of chemotherapy drugs among staff nurses working in selected oncology hospitals.

Specific objectives

- To assess the baseline knowledge of staff nurses regarding the hazards, routes of exposure, and safe handling of chemotherapy drugs.
- To assess baseline observed practice in receiving, administration, use of PPE, disposal, cleaning, and spill-response procedures within the nurses' authorised roles.
- To develop and deliver a structured teaching programme based on current professional standards and the hospitals' approved procedures.
- To compare pre-test and post-test knowledge scores after the intervention.
- To compare observed practice scores before and after the intervention and, where feasible, at a follow-up assessment.
- To examine the relationship between selected background characteristics, previous training, years of experience, knowledge scores, and practice scores.
- To identify system-level barriers that may limit the translation of knowledge into safe workplace behaviour.

Research questions

What is the baseline level of nurses' knowledge and observed safe-handling practice? Is there a measurable change in knowledge after the structured teaching programme? Is there a measurable change in observed practice, and is any improvement maintained at follow-up? Which individual or organisational factors appear to influence practice? These questions should be answered with prespecified outcomes and transparent reporting of uncertainty.

Hypotheses

The primary hypothesis is that the mean knowledge score after structured teaching will be higher than the mean baseline score. A second hypothesis is that the mean observed-practice score will improve following teaching and competency demonstration. For statistical testing, the null hypotheses state that the mean pre-test and post-test scores do not differ. The study should report effect sizes and confidence intervals alongside p-values so that the magnitude and precision of observed differences are clear.

Operational Definitions

Structured teaching programme

A planned, standardised learning package delivered using defined objectives, lesson content, teaching methods, demonstration, learner practice, feedback, and an assessment procedure. The content should be approved by oncology nursing, pharmacy, infection prevention, occupational health, and relevant safety personnel. Teaching records should document attendance and completion of required competency checks.

Knowledge of safe handling

The score obtained by a staff nurse on a content-validated questionnaire covering hazardous-drug identification, routes and consequences of exposure, risk controls, PPE, administration precautions, handling of contaminated materials and excreta, waste segregation, spill management, accidental exposure response, and incident reporting. Higher scores indicate a greater number of correct responses on the instrument used.

Practice of safe handling

The score obtained from direct observation of task-relevant behaviours using a structured checklist based on approved procedures. It may include hand hygiene, PPE selection and removal, equipment checks, line connection/disconnection precautions, disposal, cleaning, and correct escalation of spills or exposure. Behaviours should be marked only when the relevant task occurs; actions that cannot be observed should not automatically be scored as failures.

Staff nurses of selected oncology hospitals

Registered nurses employed in the participating hospitals who provide direct care to patients receiving chemotherapy or who handle contaminated materials within their defined clinical role. Eligibility should be determined by the local study protocol and institutional policy; the definition should not imply that every staff nurse is authorised to prepare cytotoxic medicines.

Review Approach and Evidence Base

This article uses a narrative review approach to organise key guidance and empirical studies relevant to occupational safety and nursing education. Priority was given to current institutional and professional standards, including the NIOSH hazardous-drug publications, United States Pharmacopeia General Chapter <800>, the ASCO–ONS antineoplastic therapy administration safety standards, and ISOPP safe-handling standards. Empirical literature was selected to illustrate environmental contamination, knowledge and practice gaps, and responses to structured education. Because this is not a registered systematic review, it does not claim exhaustive coverage or use a formal risk-of-bias meta-analysis.

The evidence base has different functions. Professional standards define recommended safety systems and task

precautions. Exposure studies demonstrate that contamination can occur across the medication pathway. Nursing surveys describe reported knowledge and self-reported practice. Quasi-experimental studies examine changes after training but may be constrained by small samples, absence of a control group, short follow-up, or reliance on self-report. These designs should not be treated as interchangeable. An educational programme may improve a questionnaire score without proving that occupational exposure has been eliminated or that rare long-term health outcomes have changed.

The review interprets findings cautiously. When a small pre–post study reports a statistically significant increase, the result provides a useful signal but does not establish that the same effect will occur in another hospital. When a study reports no short-term change in practice, this does not prove that education never works; it may indicate that a single session, measurement method, follow-up period, or work environment was insufficient. The proposed local evaluation should therefore specify how knowledge and practice will be measured and document the organisational conditions under which the teaching was delivered.

Nature of Chemotherapy and Hazardous Drugs

The term hazardous drug covers medicines with one or more characteristics that may create risk to healthcare personnel, such as carcinogenicity, genotoxicity, reproductive or developmental toxicity, organ toxicity at low doses, or a toxicity profile similar to a drug already identified as hazardous. Cytotoxic antineoplastic drugs form an important subgroup, but not every hazardous drug is a conventional cytotoxic chemotherapy agent. Conversely, the level and type of precaution required can vary by drug, dosage form, route, and the work task. The current institutional list should be checked against current NIOSH and manufacturer information rather than relying on memory or a label alone (NIOSH, 2016; NIOSH, 2024/2025; USP, 2020). The identification of carcinogenic and other occupational hazards should be interpreted using established hazard-evaluation approaches, while distinguishing an agent's hazard classification from the specific risk associated with a worker's task (IARC, 2019). A drug's hazard should be distinguished from the risk associated with a particular task. Hazard is an inherent property of the agent; risk depends on the possibility and degree of exposure under actual working conditions. Risk increases when a liquid leaks, a vial breaks, a connection is unsecured, contaminated materials are handled without suitable protection, or cleaning is incomplete. Engineering controls and closed systems can reduce exposure at source, while PPE and safe work procedures provide additional barriers. A control hierarchy is preferable to relying solely on personal behaviour because controls built into the work process are less dependent on a nurse remembering every step under time pressure (NIOSH, 2023; USP, 2020).

Medication-specific information matters. Different agents may have different stability, formulation, administration routes, and special handling requirements. The safe-handling training should not instruct staff to improvise if a product, dosage form, or administration method is not covered by the local procedure. Nurses should verify the prescribed regimen, product identity, route, rate, line compatibility, and patient-specific checks through approved medication-safety processes. If a question or discrepancy arises, administration should be paused within the nurse's scope of authority while the prescriber and oncology pharmacist clarify the plan.

Routes and Sources of Occupational Exposure

Dermal contact

Skin contact is a key potential route because low-level contamination may be present on vial exteriors, work surfaces, equipment, gloves, infusion connections, medication bins, and waste containers. Direct splashes or leaks are obvious risks, but transfer can also occur when a worker touches a contaminated surface and then the face, personal items, or other clean equipment. (Hon et al., 2013) demonstrated that surface contamination can extend across the hospital medication pathway, while (Hon et al., 2014) found that hand contamination was not restricted to workers who described direct drug contact on the day sampled. These findings support attention to shared surfaces and indirect contact.

Inhalation and aerosols

Aerosols or droplets may be generated during certain manipulations, leaks, disconnections, or cleanup of dried residues. The risk depends on the agent, formulation, work process, and available containment. Nurses should not intentionally vent, spray, or manipulate a closed system in ways that are not permitted by the relevant procedure. If a line or container is suspected to be leaking, the nurse should stop the task where safe, prevent access to the contaminated area, use the designated response process, and request trained assistance. Cleaning methods must not spread contamination or create avoidable aerosols.

Percutaneous injuries and mucous membrane exposure

A needlestick or sharps injury involving a contaminated device can introduce a drug through the skin. Eye or mucous membrane exposure may occur through splashes, particularly during disconnection or spill response. Standard sharps safety, appropriate protective eyewear when splash risk exists, and safe handling of infusion equipment are therefore essential. Staff must avoid recapping or manipulating used needles contrary to sharps policy and should place contaminated sharps directly into approved puncture-resistant containers at the point of use.

Ingestion and secondary transfer

Inadvertent ingestion can occur when contaminated hands touch food, drink, tobacco, cosmetics, phones, pens, or other personal items. Food and beverages should not be stored or consumed in areas designated for handling hazardous drugs. Hand hygiene is necessary after glove removal, but hand hygiene does not replace gloves or other controls during a task. Personal belongings should be kept outside handling zones, and nurses should avoid taking contaminated PPE into offices, break rooms, or corridors.

Evidence of Workplace Contamination and Health Concerns

Environmental monitoring studies have repeatedly identified antineoplastic drug residues on selected work surfaces in healthcare settings. (Connor et al., 2010) detected contamination in pharmacy and nursing areas at three US cancer centres despite recommended safe-handling practices. (Hon et al., 2013) observed contamination at multiple points in the Canadian hospital medication system, and (Hon et al., 2014) found detectable hand contamination among workers in different job categories. The studies use particular drugs and sampling methods, so their exact percentages should not be generalised to every hospital. The consistent lesson is that contamination can persist and that controls must cover the whole workflow.

Occupational studies have also examined reproductive and genotoxic outcomes among workers with potential exposure. (Fransman et al., 2007) pooled findings from nurses to examine trends in antineoplastic-drug exposure. The broader literature warrants prevention, but epidemiological findings require careful interpretation because workers' exposure histories, protective practices, drug mixtures, and other risk factors vary. It would be inaccurate to tell an individual nurse that exposure inevitably causes infertility or cancer. Equally, the absence of a demonstrated adverse outcome in a particular small study is not evidence that uncontrolled exposure is safe. Exposure prevention should follow precautionary occupational-health principles.

An incident report should capture the agent if known, the task, route and estimated extent of exposure, PPE used, symptoms if any, immediate decontamination performed, and occupational-health follow-up. Reporting supports prompt assessment and provides information for prevention. Staff should not delay seeking help while trying to calculate a dose or establish certainty. Local policies should identify the person responsible for clinical assessment, employee health documentation, and review of the work process. Confidentiality should be preserved according to applicable laws and hospital policy.

Core Standards and Safe-Handling Frameworks

NIOSH hazardous-drug guidance

NIOSH publishes a list to help healthcare organisations identify drugs considered hazardous and provides tools for managing exposures in healthcare settings. The 2024 list, published as DHHS (NIOSH) Publication No. 2025-103, supersedes the 2016 list and includes additions and removals. The organisation should maintain its own hazardous-drug inventory reflecting agents used locally and review it periodically, including when a new medicine or dosage form is introduced. NIOSH's earlier 2004 Alert established practical recommendations for preventing occupational exposure and has since been supplemented by updated lists and exposure-management resources. Its 2023 exposure-management document emphasises context-specific assessment because risk depends on the dosage form, task, exposure route, frequency, duration, work practice, and controls in place (NIOSH, 2004; NIOSH, 2023; NIOSH, 2016; NIOSH, 2024/2025).

USP General Chapter <800>

USP General Chapter <800> describes standards for handling hazardous drugs across receipt, storage, compounding, dispensing, administration, transport, disposal, deactivation, decontamination, cleaning, and spill control. Its approach places responsibility on the healthcare organisation as well as the individual worker. Relevant components include a designated hazardous-drug list, responsible personnel, engineering and facility controls, training, PPE, written procedures, documentation, and medical surveillance. A nurse's teaching programme should reflect the requirements adopted by the hospital and any applicable national or state rules; the chapter should not be represented as a substitute for local legal review (USP, 2020).

ASCO–ONS standards and nursing competency

The 2024 ASCO–ONS standards address safe administration of antineoplastic therapy in adult and paediatric oncology and include multiple practice settings and routes. They emphasise reliable processes, verification, safe administration, and the competency of personnel involved in therapy (Siegel et al., 2024). ONS education guidance likewise includes safe preparation and administration principles within broader chemotherapy and immunotherapy nursing competence. In practice, staff should only carry out tasks for which they are trained, credentialed when required, and authorised by institutional policy. ASHP guidance similarly emphasises a comprehensive hazardous-drug programme, including appropriate controls, PPE, and procedures for deactivation, decontamination, and cleaning (Power and Coyne, 2018). Competence should be documented and reassessed after a major practice change, a significant safety event, or a period away from relevant duties.

ISOPP safe-handling standards

The ISOPP standards give a detailed international framework for safe cytotoxic handling, including staff education, transport, administration, waste, spill response, governance, and documentation. They call for role-appropriate training and competency assessment, with retraining when practice or equipment changes and at defined intervals. Nurses should understand not only the standard sequence of tasks but also exceptions: a leaking bag, damaged container, unexplained contamination, or product not covered by local instructions. A clear escalation route prevents untrained staff from improvising in a situation that may expose people or compromise the patient's treatment (ISOPP, 2022).

Safe Handling Across the Medication Pathway

Receiving, storage and transport

Receiving personnel should inspect packages for damage or evidence of leakage using the designated procedure and appropriate protective equipment. A damaged package should not be opened casually at the receiving desk; it should be isolated and reported to the person responsible for hazardous-drug management. Hazardous medicines should be stored in clearly identified areas with

appropriate conditions, segregation, and spill supplies as required by the agent and local standard operating procedure. Access should be limited to authorised personnel, and containers should retain legible labels and relevant handling instructions.

Prepared antineoplastic products should travel in closed, labelled, protective containers designed to contain leaks and reduce breakage. A direct route and clear handover process reduce unnecessary handling. Transport personnel must know how to manage a broken or leaking package and where to find the spill response procedure. The use of routine pneumatic-tube systems should not be assumed safe; transport method must follow the hospital's specific validated policy. Responsibility should be clear at transitions between pharmacy, ward, day-care unit, and home-care teams (ISOPP, 2022).

Preparation and pharmacy interface

The preparation of injectable antineoplastic medicines should occur in the designated controlled environment by qualified personnel using the engineering controls and aseptic processes appropriate to the product. Ward nurses should not reconstitute or manipulate hazardous drugs outside the scope permitted by training and institutional policy. When receiving a prepared product, the nurse should inspect packaging for integrity, confirm patient and regimen information through the required verification process, and check for any signs of leakage, incorrect labelling, or transport damage. Any discrepancy must be resolved before administration.

Communication between pharmacy and nursing is a safety barrier. The label and accompanying instructions should communicate drug identity, dosage, route, administration duration, storage requirements, supportive medications, and special handling precautions. If an infusion device, connector, or administration set differs from that used during training, the nurse should verify compatibility and procedure before proceeding. Nurses should not change connectors, filters, dilution, or administration rate based on habit or prior experience without checking the current protocol.

Pre-administration verification

The pre-administration process should include patient identification, regimen and cycle verification, review of relevant laboratory and clinical information, allergy and previous-reaction review, assessment of venous access, and confirmation of supportive medications. The exact verification steps should follow the current ASCO–ONS standards and local policy. A structured checklist reduces reliance on memory and helps interruptions be managed safely. If the prescribed therapy, dose, route, body-surface-area calculation, weight, cycle, or laboratory findings appear inconsistent, the nurse should stop and escalate the discrepancy rather than assume it is correct (Siegel et al., 2024).

Before connecting an infusion, staff should ensure the work area is organised, the required PPE is available, the infusion device functions, the connections can be secured without undue force, and an appropriate disposal container is accessible. The nurse should explain the procedure to the patient and identify symptoms that require immediate reporting. The patient must not be expected to monitor a complex infusion in place of professional observation, but their participation can help detect discomfort or unexpected symptoms early.

Administration and line management

Administration requires correct use of the authorised route, device, tubing, connections, pump settings, and protective equipment. Nurses should minimise disconnection and manipulation, prevent leakage, and dispose of contaminated equipment as defined by the hospital. Connections should be checked for security, and the patient should be observed for infusion reactions, hypersensitivity, extravasation, and other treatment-related complications. Patient safety and staff safety are related but distinct: a procedure that avoids exposure must also preserve sterility, correct dosing, and timely recognition of complications.

Some drugs have a risk of tissue injury if extravasation occurs, while others may cause infusion reactions or haemodynamic instability. Staff should know the site-specific emergency plan, antidote availability where relevant, escalation contacts, and documentation requirements. The current drug-specific order and protocol determine the correct response. A safe-handling teaching programme should not replace separate competency in chemotherapy administration, vesicant management, or management of anaphylaxis and other clinical emergencies.

PPE selection and use

PPE should be selected according to the task, drug, exposure route, product instructions, and institutional risk assessment. Chemotherapy-tested gloves may be required, often with double gloving for specific handling activities. A protective gown should be closed at the front, have long sleeves and tight cuffs, and meet the relevant impermeability requirements. Eye and face protection is appropriate when there is splash risk, and respiratory protection may be required under specific circumstances defined by occupational health or the risk assessment. Routine examination gloves should not automatically be assumed appropriate for every hazardous-drug task (NIOSH, 2023; USP, 2020).

Donning and doffing are separate skills. Nurses should perform hand hygiene at required points, select the correct size, inspect PPE before use, avoid touching clean surfaces with contaminated gloves, and remove PPE in a way that limits skin contact with the contaminated exterior. Gloves should be changed according to procedure and immediately if torn, punctured, visibly contaminated, or otherwise compromised. Reuse of disposable PPE is not appropriate unless an explicitly validated procedure allows a particular reusable item. PPE is one component of protection, not a substitute for containment, training, or safe equipment.

Cleaning, Decontamination and Environmental Control

Cleaning and decontamination should follow a written procedure that identifies compatible agents, required

contact times, PPE, frequency, responsible staff, and documentation. These terms are not identical: cleaning removes soil and residues; decontamination reduces hazardous-drug contamination to a safer level; disinfection addresses microbial hazards. A surface that looks clean may still carry drug residue, and a disinfectant that kills microbes may not inactivate a hazardous drug. The hospital should specify the correct sequence and products based on the agents handled and current institutional policy (USP, 2020; ISOPP, 2022).

Nurses should not independently select chemicals or methods when the hospital has an approved cytotoxic cleaning protocol. They should know which items can be cleaned, which must be discarded, how contaminated materials are contained, and when environmental-services staff require specific instruction and PPE. Shared equipment, infusion pumps, bed rails, chairs, medication trolleys, and door handles can become routes for secondary transfer if responsibilities are unclear. Cleaning responsibilities should be explicit at the interface between nursing, pharmacy, and environmental services.

Routine environmental monitoring, where used, can help organisations identify recurring contamination points and evaluate control measures. Wipe sampling is not a substitute for direct observation or exposure reporting, and a negative sample does not guarantee that exposure never occurred. Sampling plans should be scientifically appropriate and interpreted by personnel with suitable expertise. Repeated positive findings should trigger a process review, not only an instruction to staff to be more careful. The organisation should assess equipment, training, work layout, drug transport, cleaning methods, and handover practices. Occupational-safety resources also emphasise controlling exposure through a combination of work practices, protective equipment, and hazard-specific procedures (OSHA, 2026; HSE, 2026).

Waste Handling and Patient Excreta Precautions

Waste generated during antineoplastic administration may include residual drug, infusion bags and tubing, contaminated PPE, absorbent material, syringes, and sharps. It should be segregated into the designated containers at the point of generation, labelled and secured, and transferred through the approved hazardous-waste pathway. Staff should not compress bags by hand, carry loose contaminated items, or place them in ordinary waste unless the local risk assessment and applicable rules explicitly permit the route. Sharps must be disposed of in puncture-resistant containers without recapping or manipulating the device.

The period during which body fluids may contain hazardous drug residues varies by medication and route. Hospitals should provide drug-specific guidance for urine, stool, vomit, drainage, and contaminated linen, including how long precautions are required. Staff handling body fluids should use the specified PPE and follow safe containment, flushing, laundering, or disposal instructions. Nurses should explain precautions to patients and caregivers in understandable language, particularly when treatment continues at home. Generic advice should not override medication-specific information from pharmacy and the treating team (ISOPP, 2022).

Waste management requires collaboration with housekeeping and waste contractors. All workers in the pathway should receive task-relevant information, even if they do not administer chemotherapy. Containers should be closed before reaching the fill line, and waste should be secured during movement through public or patient-care areas. Labels must remain visible to authorised handlers, while privacy requirements for patient information are maintained. A structured programme should cover the nursing responsibilities directly and explain how to access training for other staff who may encounter contaminated materials.

Spill Management and Accidental Exposure

Preparedness before an incident

Each area where hazardous drugs are received, administered, or where contaminated materials are handled should have access to an appropriate spill kit and a clear, rehearsed procedure. Staff must know the spill-kit location, the contact pathway, the type of spill that requires specialist assistance, and the procedure for restricting access. A spill response plan should identify role-specific responsibilities rather than assume the nurse will recall the entire sequence during a stressful event. Spill kits should be inspected and replenished after use or expiry.

Immediate response to a spill

The response depends on the agent, size and location of the spill, form of the material, and local procedure. In general, staff should protect people from further contact, restrict the area, alert appropriate personnel, and use trained responders with the required PPE and supplies. Dry powders, broken glass, large spills, and contamination involving the eyes or skin may require different actions. Untrained staff should not attempt an improvised cleanup. The team should follow the hospital protocol and consult the product-specific safety information where appropriate (NIOSH, 2023; ISOPP, 2022).

After cleanup, contaminated materials must be packaged and disposed of through the hazardous-waste route. The area may need additional cleaning or verification according to policy. The event should be documented, including what happened, where, drug identity if known, approximate quantity, exposure route, actions taken, and persons involved. Investigation should ask why the spill occurred and whether packaging, connectors, transport, workload, or equipment contributed. A non-punitive reporting culture improves the quality of this information.

Personal exposure

If a nurse experiences skin or eye contact, a needlestick, inhalation concern, or contaminated clothing, immediate decontamination and medical assessment should follow the approved exposure protocol. Staff should locate the current emergency instructions rather than rely on recollection from a prior training session. Exposure should be reported promptly to the designated supervisor and occupational-health service, with clinical evaluation based on the drug and circumstances. Any required monitoring or follow-up should be documented in the employee's

confidential health record. Post-exposure evaluation is essential even when immediate symptoms are absent.

Why Structured Teaching Is Needed

Informal instruction can produce variation: one nurse may learn safe handling through a preceptor, another through a brief orientation, and another by observing colleagues whose habits may not match current standards. A structured programme defines minimum competencies for all staff within a role and makes the training auditable. It also gives educators a consistent basis for correcting misinformation about PPE, disposal, spills, contaminated excreta, or the scope of nursing responsibilities. Repetition of key actions through practice and assessment is more likely to build procedural memory than a single information sheet alone.

The literature indicates that education can change measured knowledge, although practice outcomes are not uniformly improved. (Nouri et al., 2021) found higher knowledge and performance scores after guideline education among oncology nurses. (Shinde et al., 2022) reported improvement following a planned teaching programme, although the design and context limit broad generalisation. (Sreekumaran et al., 2025) reported increased knowledge following education on safe chemotherapy administration. By contrast, (Saker et al., 2026) observed a significant knowledge change but not significant short-term changes in self-reported practice or attitude. These studies support evaluation of both learning and behaviour, rather than treating knowledge gains as proof of practice change.

Teaching should be matched to the actual task. A nurse who administers prepared infusions needs competence in product verification, PPE, administration equipment, disconnection, waste, patient monitoring, and exposure response. A staff member authorised to handle spills needs separate practical training in the spill response. Pharmacy compounding staff require competencies beyond the general nursing module. The programme must state what it does and does not authorise. A certificate of attendance should not be treated as proof of competence when a direct observation or skills check is required by policy.

Design of the Structured Teaching Programme

Learning principles

The teaching package should move from knowledge to application. Brief lectures can explain hazards and the control hierarchy, while case discussions require learners to decide what to do when packaging is damaged or a line leaks. Demonstrations can model PPE selection, connection checks, waste segregation, and incident reporting. Return-demonstration enables an educator to observe technique and correct unsafe actions. Simulation offers a safe method for practising a spill or exposure response without using active chemotherapy. Short knowledge checks and feedback help identify misconceptions early.

Materials should use clear language and images of equipment actually stocked at the hospital. If the workforce includes different language preferences, translated materials or supported explanation may improve comprehension. The content should include common and high-consequence mistakes, not simply list policy statements. For instance, learners should be asked to identify which task requires a gown, how to respond when a glove tears, what to do if medication arrives leaking, and how to access occupational health after an exposure. The instructor should explain the rationale for each step to support flexible decision-making when circumstances vary.

Table 1. Proposed instructional modules

Module	Core content	Teaching method	Evidence of learning
1. Hazard awareness	Hazardous-drug definition, current institutional list, exposure routes, health risks, risk versus hazard.	Short lecture, illustrated slides, question-and-answer.	Knowledge quiz and discussion of realistic exposures.
2. Standard controls	Hierarchy of controls, roles, local SOPs, engineering controls, labels and safe transport.	Guided review of local procedures and work-area walk-through.	Correct identification of control measures and escalation contacts.
3. PPE	Task-based PPE selection, chemotherapy-tested gloves, gowns, eye protection, donning and doffing.	Instructor demonstration followed by return-demonstration.	Observed skills checklist.
4. Administration safety	Product verification, infusion setup, secure connections, line management, patient monitoring.	Case scenarios and demonstration using simulated equipment.	Scenario decisions and supervised practice where appropriate.

Module	Core content	Teaching method	Evidence of learning
5. Waste and body fluids	Segregation, contaminated sharps, disposal routes, excreta precautions, linen and transport.	Visual sorting exercise and scenario discussion.	Correct disposal choices and explanation of local procedure.
6. Spill and exposure	Access restriction, spill kit, skin/eye exposure, reporting, occupational-health pathway.	Simulation, role play, debriefing.	Completion of an exposure-response checklist.
7. Documentation and safety culture	Incident reporting, near misses, quality improvement, individual and organisational roles.	Group discussion and review of a sample report.	Accurate documentation and safety action plan.

Suggested duration and delivery

The programme may be delivered over two or three shorter sessions rather than a single long lecture. A practical plan might comprise 60–90 minutes of core learning, a supervised skills station, and a separate scenario exercise, with total duration adjusted to local risk, staff role, and staffing constraints. These times are suggestions rather than a universal standard. The educator should not rush a competency check to fit a timetable. If a nurse cannot demonstrate a safety-critical step, remediation and reassessment should occur before independent performance of that task, consistent with hospital policy.

Training should be offered to all eligible staff across shifts and employment arrangements. Temporary staff, newly appointed nurses, agency personnel, and staff returning after an extended absence may require additional orientation. Records should include the module, educator, date, attendance, competency results, remedial training, and next review date. A short refresher can be triggered by a new drug, device, procedure, repeated audit finding, spill, exposure, or policy revision. Staff should have access to the latest procedure when working, not merely a printed copy from an earlier training session.

Figure 1. Proposed structure of the safe-handling teaching programme and competency pathway.

Proposed Research Methodology

Research design

A quasi-experimental one-group pre-test/post-test design is feasible when the programme is introduced within selected oncology hospitals and a comparison group is not available. The design measures each participant before and after exposure to the teaching programme. If feasible, a controlled design with comparable units or staggered implementation would strengthen causal inference by helping separate the effect of training from changes in staffing, policy, equipment, or other events. The chosen design should be stated transparently and matched to institutional feasibility and ethical requirements.

The primary outcome should be specified before data collection. A reasonable primary outcome is the change in knowledge score from baseline to the immediate post-test. Observed practice can be a co-primary or secondary outcome depending on sample size and statistical plan. If a follow-up is feasible, a later observation (for example, four to twelve weeks after teaching) can help assess retention and workplace transfer. The chosen interval must be realistic, agreed in advance, and applied consistently. The study should not change outcomes or time points after reviewing results without documenting the change.

Setting and population

The setting comprises selected oncology hospitals with inpatient oncology wards, day-care chemotherapy units, or other areas where staff nurses care for patients receiving antineoplastic treatment. Before recruitment, each site should map tasks performed by its nursing workforce, current competency rules, available equipment, and local exposure-reporting arrangements. The target population is registered staff nurses who meet the protocol's inclusion criteria and whose clinical responsibilities include one or more tasks in the safe-handling pathway.

Potential inclusion criteria include current employment in a participating oncology service, provision of direct care for patients receiving chemotherapy or handling contaminated materials within the authorised role, and willingness to provide informed consent. Exclusion criteria may include nurses on extended leave during the intervention and assessment period, staff who are not involved in relevant clinical processes, or those who participated in the pilot when that could bias the main evaluation. Criteria should be practical, non-discriminatory, and approved by the ethics committee. The final protocol must state the exact criteria rather than leaving them to informal decisions during recruitment.

Sample size and sampling method

Sample size should be determined before recruitment using the primary outcome, the anticipated mean within-person change, the standard deviation of paired differences, the selected significance level, desired statistical power, and allowance for attrition. If reliable local estimates are unavailable, a pilot can inform the variance and feasibility assumptions; estimates from published studies may be used cautiously because instruments and contexts differ. The number should not be selected only because it is convenient or because a

previous study used the same sample size. If multiple hospitals participate, the analysis should consider whether site-level clustering is important.

Sampling may use total enumeration of eligible nurses within the participating services or a probability-based approach if the staff population is larger. If purposive or convenience recruitment is unavoidable, the limitation to representativeness should be stated. Recruitment should be separated from employment evaluation as far as possible so nurses do not feel coerced by managers. Refusal or withdrawal must not affect work allocation, training access, appraisal, or the nurse's professional standing. A recruitment log can document numbers screened, eligible, approached, consenting, completing the programme, and included in analysis.

Study variables

The independent variable is participation in the structured teaching programme. The main dependent variables are knowledge score and observed practice score. Potential covariates include age group, highest nursing qualification, years of general nursing experience, years in oncology, employment status, previous safe-handling training, frequency of chemotherapy-related tasks, and hospital/unit. Organisational factors may include availability of designated PPE, spill kits, written procedures, and access to trained supervisors. These variables should be limited to those with a clear rationale and collected with appropriate privacy safeguards.

Knowledge should be defined as a scored test of factual understanding and clinical decision-making. Practice should be measured through direct observation when feasible because self-report can be affected by recall and social-desirability bias. The checklist should assess only behaviours that are appropriate to the nurse's role and only during tasks where the behaviour can be observed. If a nurse does not encounter a spill during observation, the absence of a spill should not be scored as failure to manage one; spill response can be assessed by simulation.

Data collection instruments

A demographic and professional profile form can document relevant background characteristics without collecting unnecessary personal information. The structured knowledge questionnaire may include single-best-answer, multiple-choice, and scenario items. Domains should reflect current guidance: hazard classification, exposure pathways, control hierarchy, PPE, pre-administration checks, equipment handling, waste, patient excreta, spill response, post-exposure action, and reporting. Items should be unambiguous, aligned with local policy, and free of clues that reveal the correct answer by wording rather than understanding.

The observational practice checklist should list observable actions in sequence with clear scoring rules. Each item may be marked "performed correctly," "not performed/incorrect," or "not applicable/not observed," with reasons for excluded items recorded. Critical safety items should be identified in advance because a high total score should not conceal failure in a high-consequence step. Observations should be made by trained assessors who use the same definitions at all sites. When possible, a second observer should independently score a subset of observations to assess inter-rater agreement.

Instrument development should draw on NIOSH, USP, ASCO–ONS, and ISOPP guidance as well as local SOPs. A multidisciplinary expert panel may include an oncology nurse educator, clinical oncology nurse, oncology pharmacist, occupational-health specialist, infection-prevention representative, and research-methodology expert. Expert review can assess relevance, clarity, coverage, and alignment with local practice. The instrument should then be piloted with a small group outside the main sample where feasible, with attention to comprehension, time required, scoring ambiguities, and tasks that do not occur often enough to observe.

Validity and reliability

Content validity may be evaluated through expert ratings of relevance and clarity and documented revision decisions. Face validity can be explored through cognitive interviewing or a pilot to determine how nurses interpret questions. Internal consistency may be estimated for an appropriate multi-item knowledge scale, but a high coefficient does not prove that the questionnaire covers all essential safety domains. For an observational checklist, inter-rater agreement is important; percentage agreement or an appropriate kappa statistic can be reported depending on item structure and prevalence. Test–retest reliability may be considered for stable knowledge items, provided that participants do not receive the intervention between measurements.

Reliability coefficients should be reported with their sample and method; they should not be invented in advance. When instruments are adapted from existing tools, permission and attribution should be obtained where required. If local standard operating procedures change during the study, the research team should document the timing and assess whether the change affects comparability. A short, clear tool that measures key behaviours well is preferable to a long questionnaire containing repetitive or low-value items.

Intervention delivery

The educator should use a written lesson plan so all participants receive comparable core content. The sequence should include a pre-test, explanation of the intervention, teaching sessions, demonstration, return-demonstration, immediate feedback, post-test, and recording of any remedial support. If competency is not demonstrated, the nurse should receive additional supervised practice and reassessment under the hospital's safety policy. For research integrity, the study team should record deviations from delivery, attendance, interruptions, and any equipment shortage that affects practical learning.

To strengthen transfer into daily work, the intervention can include a brief job aid placed in the clinical area, reference cards for spill response, and clear directions for finding the full standard operating procedure. These resources should reinforce rather than replace education. The workplace should be checked to confirm that the supplies shown during teaching are actually available and approved. A

programme that demonstrates a piece of equipment unavailable on the ward may improve test performance but will not reliably support practice.

Data collection procedure

After institutional and ethics approvals, the researcher should coordinate with the nursing superintendent and unit leadership to approach eligible staff without coercion. Nurses who consent can complete the baseline questionnaire under consistent conditions. Practice observation should be scheduled to minimise disruption to care and should use a discreet, standardised approach; it must never delay an urgent clinical intervention or compromise patient privacy. Baseline observations should be limited to routine tasks and simulations, with no unsafe activity introduced solely for research purposes.

The structured teaching programme should then be delivered using the approved lesson plan. Post-test knowledge assessment should use the same instrument or an equivalent form with comparable difficulty, avoiding unnecessary coaching on exact test answers. Follow-up practice observations should occur in a prespecified window. Where feasible, the observer should not know the participant's baseline score, which can reduce expectation bias. Any observed serious unsafe action should be managed immediately according to clinical governance and safety policy; research procedures cannot take priority over patient or worker protection.

Data Management and Statistical Analysis Plan

Data should be assigned study codes and stored securely, with the participant-identification key kept separately and access limited to authorised team members. Paper forms should be secured in locked storage; electronic data should be protected by access controls and approved institutional systems. The dataset should be checked for impossible values, duplicated records, missing items, and inconsistencies between assessment dates. A prespecified codebook should define each variable, scoring rule, allowable range, and treatment of "not applicable" observations.

Descriptive statistics should summarise the sample and baseline context. Continuous variables may be described using means and standard deviations when distributions are reasonably symmetric, or medians and interquartile ranges when skewed. Categorical variables should be reported as counts and percentages. Knowledge and practice scores should be presented with their scale ranges and clear definitions. Where informative, the proportion meeting a prespecified competency threshold and the proportion demonstrating each critical safety behaviour should be reported, not only a single overall average.

For paired pre-test and post-test scores, a paired t-test may be appropriate when the differences are approximately normally distributed and the measurement scale supports the method. A Wilcoxon signed-rank test may be more suitable for markedly non-normal paired data or ordinal scores. McNemar's test can be used for paired binary outcomes, and repeated-measures models may be considered if several follow-up time points are planned. For multiple hospitals or units, analyses may need to account for clustering or site effects. The statistical plan should be finalised with a qualified statistician before data inspection.

Report the estimated mean or median change, effect size, 95% confidence interval where appropriate, and p-value. Statistical significance should not be mistaken for clinical or operational significance. A small improvement could be statistically detectable but insufficient to ensure safety-critical tasks are reliably completed. Conversely, a potentially useful improvement may have a wide confidence interval in a small sample. Missing data, participant attrition, protocol deviations, and reasons for unavailable practice observations should be documented. Analyses should follow the prespecified primary outcome and avoid multiple unplanned tests that inflate false-positive risk.

Potential associations between background variables and outcomes may be explored if the sample is large enough. Regression modelling should not include more parameters than the data can support. Results should avoid blaming nurses when practice gaps reflect a resource shortage or system design. Where relevant, process measures such as PPE availability, presence of spill kits, and completion of refresher training should be reported alongside nurse-level scores. This gives administrators more actionable information than attributing every shortfall to an individual knowledge deficit.

Ethical Considerations

The study requires approval from the relevant institutional ethics committee or review board and permission from each participating hospital. Participation should be voluntary and based on informed consent. The information sheet should explain the purpose, procedures, possible discomfort, confidentiality protections, intended use of data, and right to withdraw without penalty. Managers should not receive individual questionnaire or observation scores for employment appraisal unless a separate, clearly explained clinical competency process requires action under policy. Research records and routine competency records should be distinguished.

Observing nursing practice may create anxiety that the research is an employment assessment. To reduce this risk, the team should explain how observations will be used and who can access identifiable data. At the same time, the researcher cannot ignore an imminent risk to a patient or worker. The protocol should specify how an unsafe act is escalated, how confidentiality is balanced with safety responsibilities, and how corrective support will be provided. Participants should not be asked to demonstrate hazardous acts outside normal approved practice.

Equity requires that staff on night shifts, part-time schedules, or different employment arrangements have a fair opportunity to attend training. If a nurse fails an assessment, remediation should focus on safe competence rather than shame or punishment. Research reports should present aggregate results and avoid small-group descriptions that could identify individuals. Data retention and disposal should follow local policy and applicable

data-protection requirements. Conflicts of interest and funding sources should be declared in the final report.

Expected Outcomes and Interpretation Plan

The planned evaluation is expected to clarify whether the teaching programme improves knowledge scores, whether observable practice changes, and whether the improvement persists at follow-up. These are expected outcomes, not results. It would be inappropriate to state a pre- or post-test mean, a percentage of nurses achieving a "good" level, or a p-value before data have been collected and analysed. Once implemented, the study should report actual findings even when they are smaller than anticipated or fail to reach statistical significance.

If knowledge improves but practice does not, the finding should trigger examination of the work environment, including equipment availability, time pressure, staffing, clarity of standard procedures, peer norms, and opportunities for coaching. It may also indicate that the checklist is poorly matched to routine tasks or that the follow-up period was too short. If practice improves immediately but returns toward baseline later, refresher training, periodic observation, feedback, and supervisor reinforcement may be needed. If neither score improves, the intervention content, delivery method, instrument quality, and implementation fidelity should be reviewed before concluding that education has no value.

A meaningful interpretation links score changes to individual critical behaviours. For example, improved knowledge of PPE requirements is useful, but a hospital should also examine whether the correct PPE is available and used. A higher total practice score should not obscure repeated errors in spill response or disposal. Results should be compared with the local baseline, relevant standards, and prior studies while acknowledging differences in instruments and participants. Recommendations should be proportional to the strength of the evidence and the limitations of the design.

Figure 2. Proposed study flow and evaluation points for the structured teaching intervention.

Implementation Barriers and Facilitators

Common barriers include limited time for education, staff shortages, high clinical workload, turnover, inconsistent availability of PPE, unclear local procedures, inadequate spill kits, weak feedback after audits, and differences between equipment used in training and equipment available during care. Nurses may also feel that precautions make tasks slower or may underestimate indirect contamination. These barriers need to be measured rather than assumed. A short staff survey, interviews with educators, review of incident reports, and direct environmental assessment can help determine which obstacles are most relevant in each unit.

Facilitators include visible leadership support, protected education time, ready access to approved supplies, supportive supervisors, clear escalation pathways, unit champions, regular safety huddles, and non-punitive incident reporting. Standardised job aids can make procedures easier to recall at the point of care. A designated multidisciplinary group should periodically review hazardous-drug policies, new medicines, reported exposures, contamination findings, and competency outcomes. Learning is more durable when the organisation demonstrates that safety is a shared priority rather than an individual nurse's responsibility alone.

The intervention should be integrated into onboarding and continuing professional development. Competency records should be accessible to relevant leaders without unnecessary disclosure of assessment details. A plan is needed for replacement training when staff transfer between hospitals or return after an extended absence. Where resources are limited, hospitals should prioritise critical controls and ensure that the teaching does not imply that PPE can compensate for absent engineering controls. Procurement, occupational health, pharmacy, infection prevention, and nursing management should share responsibility for implementation.

Quality Indicators and Sustainability

A sustainable programme should measure both learning and the conditions required for safe performance. Useful indicators include the percentage of eligible staff completing training, the percentage passing the competency assessment, the proportion of observed tasks in which required PPE is used correctly, compliance with approved waste pathways, availability of in-date spill kits, completion of exposure reports, and closure of corrective actions after an incident. Each indicator needs an operational definition, numerator, denominator, data source, collection frequency, and named owner.

A balanced dashboard should avoid punishing units for reporting more incidents. A rise in reports after training may indicate improved recognition and reporting rather than a true increase in exposure. Trends should be interpreted with contextual information such as chemotherapy volume, staffing changes, product mix, and changes in observation intensity. Near misses and small spills should be analysed for recurring patterns. Audit findings should be shared promptly with staff and translated into practical corrective actions, such as moving a spill kit to a more accessible location or revising an unclear disposal instruction.

Sustainability also requires periodic review of the teaching material. The current NIOSH hazardous-drug list, professional standards, medication technology, and hospital formulary may change. A named owner should monitor relevant updates and coordinate revisions with pharmacy, occupational health, nursing education, and hospital policy teams. Old printed copies should be withdrawn or clearly marked as uncontrolled. Whenever a significant change occurs, staff should be briefed and competency rechecked if the change alters a safety-critical task (NIOSH, 2024/2025; Siegel et al., 2024).

Role of the Nurse Educator and Oncology Nurse

The nurse educator translates complex guidelines into task-specific learning that matches the staff member's scope of practice. This requires collaboration with pharmacists, occupational-health staff, infection prevention, environmental services, and clinical managers. Educators should demonstrate skills consistently, use

realistic scenarios, assess learners fairly, document outcomes, and arrange remediation. Their role also includes identifying whether an error is caused by an individual knowledge gap or by the work system. Education is most effective when findings lead to improvements in both competence and the environment in which nurses work.

The oncology nurse is responsible for working within authorised competence, using required precautions, checking products and orders, communicating discrepancies, documenting care, and reporting spills or exposure promptly. Nurses should ask for clarification when a procedure is unfamiliar or when equipment is damaged or unavailable. They should not feel compelled to improvise outside the approved process because a medication is urgent. Escalation and pause points are part of safe practice, not evidence of poor performance. Patients should receive timely, appropriate therapy, but urgency does not remove occupational safety requirements.

Teamwork is essential because chemotherapy safety crosses professional boundaries. Pharmacy controls preparation and labelling; nursing verifies and administers according to standards; occupational health manages exposure assessment and worker follow-up; environmental services follows approved contamination-control procedures; supply teams ensure equipment and PPE are available; and leaders maintain policy and staffing support. The teaching programme should make these responsibilities visible so nurses know what they can resolve directly and when to contact another service.

Implications for Nursing Practice, Administration and Research

Nursing practice

For bedside practice, the review supports a consistent workflow: confirm the drug and local procedure, prepare the authorised work area, choose task-appropriate PPE, verify the patient and regimen, administer with secure equipment, observe the patient, dispose of contaminated materials correctly, and report any suspected exposure. Each step should be supported by an accessible procedure and periodic competency assessment. Nurses should be able to explain why precautions are required and identify how to respond when an unexpected event interrupts the normal sequence.

Nursing administration

For nursing administrators, the central implication is to create the conditions required for safe behaviour. This includes protected training time, role-appropriate competency records, reliable PPE procurement, accessible spill kits, clear instructions for body-fluid precautions, safe waste containers, and a non-punitive incident-reporting pathway. Managers should review staffing and workload as safety variables rather than assume that a single teaching session will fix missed steps. Investment in training should be linked to a process for acting on audit findings.

Research

Future studies should use larger and more diverse samples, comparison groups where feasible, validated tools, direct observation, and longer follow-up. Multicentre designs can help determine which intervention components are transferable across hospitals. Researchers should consider measuring environmental contamination or process indicators in addition to knowledge and practice, while using qualified occupational-hygiene methods. Research should also examine the effect of ongoing coaching, digital reminders, simulation, supervisor feedback, and resource interventions. Better reporting of intervention content and fidelity will allow other hospitals to reproduce useful programmes.

Strengths and Limitations of the Proposed Approach

A strength of the proposed protocol is its integration of current safety guidance with a measurable educational intervention. By including both a knowledge questionnaire and an observational checklist, it avoids relying entirely on self-reported confidence. Follow-up measurement can assess whether improvements persist, and collection of resource-related information can help interpret performance gaps. The proposed teaching modules are adaptable to different oncology services while allowing core safety competencies to remain consistent.

The one-group pre–post design has important limitations. Without a comparison group, improvements could reflect repeated testing, changes in procedures, informal learning, observation effects, or other events occurring during the study. Nurses may change behaviour when observed, and self-report may overestimate compliance. Low-frequency events such as spills cannot be assessed reliably by routine observation alone and may require simulation. A small or convenience sample may not represent all oncology nurses. These limitations should be stated in the final report, and causal claims should be modest.

The narrative review itself is not exhaustive and does not provide pooled effect estimates. Standards and requirements can vary by country, drug formulation, and institutional setting. The final protocol must therefore be checked against current local regulations and the selected hospitals' approved standard operating procedures. The results, when available, should not be generalised beyond the population and context studied without qualification. Most importantly, no primary study outcomes are supplied in this document; effectiveness remains a question to be answered by the proposed evaluation.

Recommendations

- Conduct a baseline assessment of nurses' knowledge and observed practice before finalising teaching content, and use the findings to prioritise high-risk tasks.
- Align all instructional material with the current institutional hazardous-drug list, updated professional standards, and local standard operating procedures.
- Use demonstration, return-demonstration, scenario-based learning, and competency assessment rather than relying on lecture or attendance alone.

- Ensure suitable PPE, safe equipment, waste containers, spill kits, and current written procedures are available before expecting staff to demonstrate compliance.
- Include a prespecified follow-up assessment to examine retention and workplace transfer, and report effect sizes and confidence intervals with the statistical results.
- Review incident reports, near misses, environmental findings where available, and audit results as system-level learning opportunities.
- Provide refresher education after significant policy or device changes, relevant safety events, extended absence, or periodic competency review.
- Maintain confidentiality, voluntary participation, and an explicit procedure for escalating immediate safety risks encountered during research observations.

Conclusion

Safe handling of chemotherapy drugs is an essential component of occupational health, medication safety, and quality oncology nursing. Exposure can occur across the medication pathway and may affect staff who do not directly prepare or administer chemotherapy. Current professional standards call for a comprehensive system that combines hazard identification, appropriate engineering controls, task-specific PPE, written procedures, safe transport and disposal, cleaning, spill response, training, documentation, and occupational-health support. Knowledge is necessary but not sufficient; nurses need the resources and workplace conditions that make the safest action practical.

A structured teaching programme can provide a consistent foundation for understanding and performing safe-handling procedures. Empirical studies indicate that education can improve knowledge and may improve observed practice, although effects differ by intervention design, measurement method, follow-up, and organisational context. The proposed study should assess knowledge and observed practice separately, include competency demonstration, and avoid assuming that an immediate post-test score proves sustained behaviour change. If the evaluation identifies gaps, hospitals should respond with targeted teaching and system-level correction.

The selected oncology hospitals should implement the protocol only after ethics approval, site permission, instrument validation, and finalisation of the sample-size and analysis plan. Actual data should be collected and reported transparently; no results should be inferred from the review. The most defensible outcome is a continuous learning system in which nurses receive role-appropriate training, demonstrate competence, access necessary supplies, report incidents without fear, and work within a coordinated programme to prevent hazardous-drug exposure.

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