

# Assess the Risk Factors of Handling Chemotherapy Among Nurses & Pharmacist

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## Abstract

Handling chemotherapy agents poses a critical occupational risk for healthcare workers, particularly nurses and pharmacists. Although the health sector has implemented advanced security measures, these health care practitioners remain exposed and consequently face the risks of suffering acute and long-term health outcomes. This systematic review aimed at reviewing recent findings on risk factors, occupational risks, and the efficacy of preventive practices regarding the manipulation of chemotherapy drugs. For this purpose, peer-reviewed databases were searched systematically to identify studies that were published between 2018 to 2025. Studies were included based on their focus on examining occupational exposure, knowledge, attitudes, and adherence to safety protocols in nurses and pharmacists. Data was extracted and synthesized thematically, based on the findings and gaps in the literature. The occupational hazards included reproductive complications, acute symptoms, and chronic conditions. Factors that contributed to exposure included inadequate training, inconsistent use of Personal Protective Equipment (PPE), and lack of infrastructure. Healthcare worker's compliance with safety procedures varied, depending on the pressure of workload, organizational barriers, and knowledge deficits. Even though there are structured training programs and safety interventions that improve compliance, large gaps persist, especially in low-resource settings. Findings highlighted the need for an integrated approach in managing risk factors, which involves frequent training, investment in safety infrastructure, and building an effective organizational safety culture.

**Keywords:** Chemotherapy drugs, Occupational exposure, Antineoplastic Agent, Cytotoxic drugs, Safe handling, Oncology nurses.

## Introduction

Chemotherapy drugs are being used in healthcare settings to treat patients who are suffering from cancerous and non-cancerous diseases. The use of chemotherapy drugs is associated with several health care risk among nurses and pharmacist (Society, 2019). The exposure to chemotherapy agents include inhalation, injection of sharp objects, hand-to-mouth ingestion, and skin or mucous membrane contamination. The handling of chemotherapeutic drugs usually is involved in preparation, patient administration, disposal, or spill management (Andrews & Dill, 2018). Healthcare workers are exposed to harmful chemical and drugs present at their workplace (Rai et al., 2021). Nurses and pharmacists are at the forefront of using chemotherapy drugs as part of the treatment for cancer. To deliver the best possible care to patients and reduce associated hazards, these medical professionals play a role in the preparation, administration, and disposal of chemotherapy agents.

However, due to their inherent toxicity and potential for exposure, the manipulation of chemotherapeutic drugs poses significant occupational hazards (Graham et al., 2020). National Institute for Occupational Safety and Health estimated that approximately 8 million health care workers were exposed to hazardous agents that included chemotherapy as well (Connor et al., 2008).

Chemotherapy medications, which are categorized as antineoplastic medicines, are intended to target cancer cells that divide quickly, frequently causing harm to healthy cells in the process (Mustapha et al., 2021). As, chemotherapy agents are widely used to treat cancer patients therefore the increased risk of nurses exposure also increases. A study conducted by Weir et al. (2021) reported a 50% increase in cancer cases by 2050 (Weir et al., 2021). As they are cytotoxic, they are dangerous to patients as well as medical personnel who come into touch with them. Prolonged use of chemotherapy medications has been linked to major health

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problems, including long-term impacts like reproductive problems, genetic abnormalities, and an increased risk of cancer, as well as acute symptoms like nausea, dizziness, and rashes (Gamal et al., 2019).

Due to the nature of the jobs, nurses and pharmacists are especially at risk. When administering chemotherapy, nurses frequently handle the medication, and pharmacists prepare and combine these drugs (Connor et al., 2016). A study by DeJoy et al. (2017) reported that 16.9% of health care workers including nurses were exposed to hazardous agents as chemotherapy last year (DeJoy et al., 2017). Inadequate training, inappropriate use of personal protection equipment (PPE), and inadequate workplace safety procedures are some of the variables that increases the dangers connected with handling chemotherapy (Nassan et al., 2021). Developing a solution that helps to protect health workers and maintain a safe workplace develops based on risk variables. Researchers have reported chemotherapy spill events with 61 chemotherapy exposure events, 11 exposure events, within two years for 12 oncology sites. According to such reports from 51 nurses, it is becoming even more imperative to analyze these risk factors to implement effective measures for the protection of healthcare workers from chemotherapy exposure. (Mendelsohn-Victor et al., 2020).

Improving safety conditions for workers in hospitals reduces risks associated with chemotherapy management. In managing dangerous drugs and medications, there is a need to observe the appropriate safety measures to reduce exposure (Ibrahim et al., 2019). For this, World Health Organization (WHO) in collaboration with International Society of Oncology Pharmacy Practitioners (ISOPP) and Oncology Nursing Society (ONS) have ensured proper safety guidelines that should be applied (Ejupi et al., 2020). The findings show inconsistency in compliance with the safety guidelines in place, despite such regulations, thus implying a need for more resources, implementation, or awareness.

This paper seeks to provide research-based knowledge that can be applied to safety programs, training, and policy making by acknowledging the specific challenges nurses and pharmacists face. In addition, it contributes to the greater debate on occupational health by highlighting the need for structural changes that ensure the welfare of healthcare professionals.

This systematic review aims at determining the risk factors associated with chemotherapy handling by nurses and pharmacists. It aims to answer the following research

questions:

1. What are the occupational hazards in handling chemotherapy drugs by nurses and pharmacists?
2. Which factors increase the exposure of healthcare personnel to chemotherapy agents?
3. What is the current level of preventive measures and safety protocols in place, and how effective are they?

### Literature Review

Chemotherapy drugs administered to cancer patients have dangers of occupational health risks to individuals handling them, such as nurses and pharmacists. Highly complex and toxic agents require extreme safety precautions that affect exposure.

Knowledge, attitudes, and practices among oncology nurses with regard to handling cytotoxic drugs safely have become a major contributing factor in minimizing the risk of exposure at the place of work. HA et al. (2019) cross-sectional study in Tanta University Hospitals explores these three areas among oncology nurses. The study results showed significant gaps in knowledge and inconsistent adherence to safe-handling practices, with most nurses unaware of the proper protocol for managing cytotoxic drugs (Alehashem & Baniyasi, 2018). Moreover, it was found that the positive attitude towards safety cannot always ensure the practice of safety because of certain organizational barriers, such as the lack of adequate training and reduced availability of PPE. Therefore, it becomes evident that the effective approach followed through repeated educational programs and institutional supports is to fill knowledge gaps, improve attitudes, and then to consistently apply safe practices in handling chemotherapy. These findings are similar to broader research studies that stress the interplay between knowledge, attitudes, and systemic factors in shaping safety compliance (HA et al., 2019).

Apart from acute symptoms, chronic exposure has been linked to carcinogenic and mutagenic effects. Kim et al. found in 2019 that a large percentage of nurses who handled chemotherapy did not follow proper safety procedures, thus increasing the likelihood of late health effects from secondary cancers (Kim et al., 2019).

Knowledge gaps are still an ongoing problem when it comes to safe chemotherapy handling. Studies that have been conducted consecutively reveal that less training is given to the health care workers. To support this, Ibrahim et al. (2019) established that most of the pharmacists and oncology nurses did not know the dangers brought about

by oral chemotherapeutic agents, which set them up for risks by hazardous intravenous drugs (Ibrahim et al., 2019). Pirot et al. (2023) concluded that the poor training among home care nurses had a negative impact on the latter's preventive practices as less than half had received any form of formal training on the administration of antineoplastic drugs (Pirot et al., 2024).

In oncology nursing, knowledge about exposure to cytotoxic drugs and attitudes toward the exposure relate closely with adherence to safety protocols. Manesh et al. (2019) researched this interplay among oncology nurses. In most cases, the nurses knew the risks; however, their perceptions regarding the real danger posed by the risk of exposure were mainly wrong and their adherence to the implementation of safety measures differed. The identified factors for such exposure were deficient education and a lack of emphasis on the development of a safety culture in organizations. The researchers called for systemic training programs coupled with regular updating and reminder of guidelines related to safety.

The gaps may be bridged through structured interventions. Friese and Aebersold (2019) developed an inter professional training program for nurses and pharmacists, integrating online modules with simulations, to enhance chemotherapy safety. The comprehensive and structured learning improved the participants' knowledge and confidence, indicating that ongoing education is essential for safe handling (Friese & Aebersold, 2019).

Despite the existence of safety directives, compliance was still inadequate. According to a study by Ogbaghebriel et al. (2022) most pharmacies complied with all basic safety interventions, but deficiencies in critical intervention areas, among them re-wearing disposable gown and inconsistent provision of eye protecting, remained. This noncompliance, facilitated by barriers for discomfort and not having adequate quantities of PPE, increases dangers

of exposure significantly (Ogbaghebriel et al., 2022). Organizational factors determine safe handling of chemotherapy. Kim et al. (2019) described the impact of a safety climate as supportive and the implications that can lead to adherence to the guidelines in the handling of chemotherapy. Through his research he determined feedback, training, and no job hindrance had positive correlation with the rate of adherence. (Kim et al., 2019).

In comparison studies such as Pirot et al. (2023) show that inadequately prepared facilities and heavy workloads impede the safe practices of staff members. Exposure risk is compounded further by the absence of biological safety cabinets and dedicated preparation areas. These environmental challenges would require systemic change, such as providing sufficient resources and infrastructure (Pirot et al., 2024).

There is neglect in conducting routine health monitoring on health workers handling chemotherapy drugs. Ogbaghebriel et al. (2022) pointed out that about half of the surveyed pharmacy practitioners lacked access to medical surveillance. In such cases, this absence of programs leads to undetected long-term health effects on exposed workers (Ogbaghebriel et al., 2022).

## Research methodology

### Search Strategy

The systematic literature review provides a comprehensive analysis of the authentic published studies. This process involves a multifaceted approach, finding relevant and authentic sources. For the present study, the 6 years' studies were chosen that were published between 2019 and 2024. These studies were accessed using three databases, Sage Journal, PubMed, and Science Direct. The articles were accessed using specific search strings and keywords. Table 1 shows the specific search strings and search terms that were used to collect data.

Database	Search strings	Search terms
Sage Journal	“chemo AND antineoplastic”, “exposure AND preventive measures”, “pharmacists AND occupational hazards” and “PPE”, “risk factors”, “preventive measures”, and “personal protective gear	Chemo, antineoplastic, exposure, nurse, pharmacists, occupational hazards, PPE, risk factors

Database	Search strings	Search terms
PubMed	"chemotherapy" OR "anticancer drugs" "safety measures" OR "occupational hazards" "chemotherapy" OR "anticancer drugs"	Preventive measures, personal protective gear, occupational hazards, antineoplastic, chemo
Science Direct	"chemotherapy" OR "antineoplastic agents" "safety measures" OR "personal protective gear" "nurses" OR "pharmacists"	Risk factors, nurses, pharmacists, occupational hazards, personal protective equipment

*Table 1: Search Strategy*

### ***Inclusion and Exclusion Criteria***

Table 2 shows the exclusion and inclusion criteria

chosen for the present study to gather data

Inclusion	Exclusion
Nurses and pharmacists handling chemotherapy	Other healthcare workers or general population
Studies published in peer reviewed journals including original and review articles	Studies not published in peer reviewed journal
Studies published in English language	Studies published in languages other than English
Studies published between 2019–2024	Studies not published between 2019-2024
Studies focused on Risk factors, occupational exposure, and preventive measures for chemotherapy handling	Studies not focused on risk factors or preventive measures for chemotherapy

### ***Data Extraction & Analysis***

For a systematic literature review, a total of 9 studies were included chosen. These studies were chosen based on their relevance with the research topic, title of the research, and the purpose of the research. Full text articles were obtained against the pre- defined exclusion criteria.

### ***PRISMA***

A total of 861 studies were identified through the different databases search. 34 studies were obtained after removing duplicates and studies marked as ineligible of which only 9 studies were included in the review.

The literature review of the chosen studies shows the risk factors, safety measures, and knowledge gap of handling chemotherapy agents among the nurses and pharmacists. Important themes include predictors of safe-handling compliance, knowledge deficits, organizational barriers, and health hazards among healthcare workers. The following is a synthesis of the findings:

### ***Knowledge Deficits and Training Impact***

One major problem which was constantly mentioned in most studies was the lack of knowledge. (Abu-Alhaja et al., 2023) cited that ignorance of guidelines, and a lack of consistent training led to unsafe nursing practices. Likewise, (Yu, 2020) cited the fact that there is a lack of standard training, uneven enforcement of safety guidelines as challenges that persisted in Hong Kong. (Sajji et al., 2024) showed the impact of educational interventions through structured training programs improved nurses' knowledge and practices significantly. (Zalhaf et al., 2024) found that an occupational health safety program improved nurses' perception and compliance with safe-handling protocols.

### ***Organizational Barriers***

Various studies have highlighted organizational barriers, such as poor infrastructures, unavailability of proper PPE, and workload pressure. (Fentie et al., 2023) found inadequate facilities for chemotherapy handling and

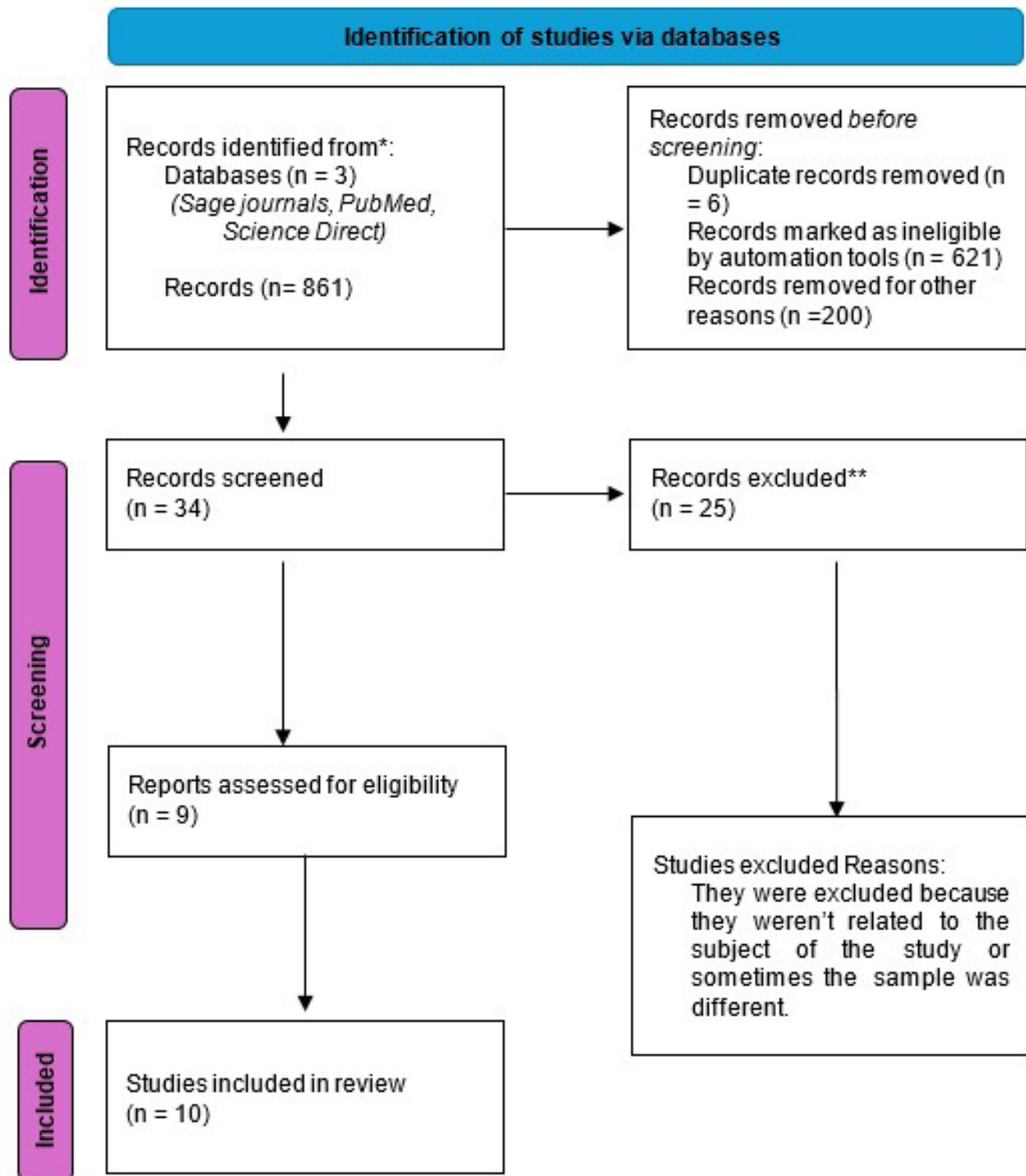


Figure 1: PRISMA Flow Diagram

**Results**

<b>Year</b>	<b>Author</b>			<b>Topic</b>			<b>Methodology</b>		
<b>2019</b>	(Lawson et al., 2019)	(DM et al., 2019)	(Garnal et al., 2019)	PPE use by nurses	Health hazards in Egypt	Health hazards in oncology	Survey-based study	Cross-sectional study	Descriptive cross-sectional study
<b>2020</b>	(Yu, 2020)			Occupational exposure to chemotherapy drugs			Literature review		
<b>2021</b>	(Abu Sharour et al., 2021)	(Nassan et al., 2021)		Predictors of chemotherapy safe handling	Handling chemotherapy and miscarriage risk		Cross-sectional study	Prospective cohort study	
<b>2023</b>	(Abu-Alhaija et al., 2023)	(Fentie et al., 2023)		Factors influencing chemotherapy exposure	Chemotherapy supply chain in Ethiopia		Integrative review	Mixed-methods study	
<b>2024</b>	(Zalhaf et al., 2024)	(Sajji et al., 2024)		Occupational Health Safety Program	Nurse education on chemotherapy safety		Quasi-experimental study	Pre-experimental study	

Key Findings			Future Implications		
Pregnant nurses handled fewer chemotherapy agents; nonpregnant nurses had inconsistent PPE use	High prevalence of chemotherapy-related health issues, poor adherence to safety measures	High prevalence of health issues, poor safe handling adherence	Strengthen PPE policies for all nurses	Increase training and monitor adherence	Enhanced training and PPE provision
Gaps in training, inconsistent guidelines			Develop enforceable safety guidelines		
Knowledge, risk perception, barriers, and workplace influence affect safe handling	Increased miscarriage risk with chemotherapy handling during pregnancy		Regular safety evaluations and training	Promote PPE usage, restrict high-risk tasks for pregnant workers	
Inadequate PPE, insufficient training, workload pressures	Poor handling infrastructure, disposal issues, insufficient staff training		Improve safety measures, PPE compliance, and training	Invest in infrastructure, training, and policy reforms	
Improved perception and practices post-intervention	Significant improvement in nurses' knowledge and practices post-training		Implement regular occupational health safety programs	Regular structured educational programs to sustain safety practices	

Table 2: Results

disposal facilities in Ethiopia, making the practices unsafe. (DM et al., 2019) concluded that lack of proper adherence to safety protocols in Egypt was further challenged by a lack of the necessary protective equipment and the poor monitoring systems.

Another major factor was workload. As stated by (Abu-Alhaija et al., 2023), the stress of managing a large number

of patients and the insufficient workforce further exposed the patients to chemotherapy drugs since the precautions required were rushed or not implemented appropriately.

#### **Health Hazards and Occupational Risks**

The studies also highlighted the very severe health risks associated with chemotherapy agents and the health

professionals' exposure risks. According to (Nassan et al., 2021) exposure to antineoplastic drugs during pregnancy increased the risk of miscarriage among those nurses not applying PPE in a consistent manner. (Gamal et al., 2019) reported that some common health issues among oncology nurses in Egypt included skin irritation, menstrual irregularities, and allergic reactions due to improper handling and inadequate protective measures.

### ***Effectiveness of Safety Measures***

A study by Lawson et al., (2019) concluded that pregnant nurses were less likely to administer chemotherapy agents and thus represented a form of risk mitigation, non-pregnant nurses had inconsistent use of personal protective equipment; the least used was gowns (Lawson et al., 2019). Safety programs was shown by (Zalhaf et al., 2024) to improve practices and reduce exposure risks, with major emphasis on institutional initiatives.

### **Discussion**

Occupational hazards in handling chemotherapy  
Chemotherapy drugs are related to a myriad of health problems including reproductive problems, skin irritation, allergic reactions, and risk to cancer. Studies conducted by Nassan et al. (2021) and Gamal et al. (2019) highlighted reproductive complications including miscarriage and menstrual irregularities as high risks among nurses as exposed to chemotherapy agents (Gamal et al., 2019; Nassan et al., 2021). These findings are also supported by Connor et al. (2016) that observed high risks of carcinogenicity, teratogenicity, and mutagenicity in nurses who are exposed to chemotherapy agents (Connor et al., 2016).

In addition, symptoms such as nausea, dizziness, and irritation of the respiratory system are often mentioned, especially when exposure to antineoplastic drugs is protracted. A study conducted by Momeni et al. (2021) support the findings as drug contamination on the work surface to be one of the major exposure sources. The studies highlight a critical need for adequate safety practices to reduce occupational health hazards of nurses and pharmacists (Momeni et al., 2021).

Exposure of healthcare personnel to chemotherapy agents  
Several factors contribute to increased exposure to chemotherapy agents. These range from insufficient knowledge and improper use of PPE by professionals, to challenges within the organization. This aligns with Asefa et al. (2021), who highlighted that 69% nurses about

inadequate awareness about guidelines for safe handling at work place and suboptimal use of PPE (Asefa et al., 2021). Furthermore, the increased workload and staff shortage make unsafe practice even worse. Che Huei et al. (2020) found that overloaded health professionals avoid safety precautions as they have limited time (Che Huei et al., 2020). The conclusion is further supported by the fact that the results of (Abu-Alhaija et al., 2023) point to the major obstacle as being pressure due to workload. In addition, lack of infrastructure such as biological safety cabinets and safe areas for handling drugs was highlighted in the present study and supported by von Grünigen et al. (2011) who indicated that poor work environment conditions are related to higher contamination risk (von Grünigen et al., 2022).

### **Preventive measures and safety protocols**

The current study established that there was a significant variability in the implementation and effectiveness of preventive measures. In some institutions, robust safety protocols are adopted, while in others, gaps remain in PPE availability, training frequency, and adherence to guidelines. For instance, studies by Lawson et al. (2019) and Ogbaghebriel et al. (2022) demonstrated widespread PPE use among healthcare workers; however, inconsistencies persist, especially in the use of gowns and eye protection (Lawson et al., 2019; Ogbaghebriel et al., 2022).

The present study's results and comparison with previous literature bring to light remarkable advancements in understanding and mitigating the risks associated with chemotherapy drugs. However, it is essential that the knowledge gap, compliance, and infrastructure remain areas of continued focus. Ensuring the safety of nurses and pharmacists is crucial while still upholding quality care for patients through evidence-based interventions and creating a culture of safety.

### **Conclusion**

The present systematic review highlights the dangers associated with the handling of chemotherapy drugs among nurses and pharmacist. The review highlighted issues like reproductive issues and acute health symptomatology and chronic conditions. Other factors identified for exposure of nurses included inappropriate training, inappropriateness of PPE, and high organizational barriers for instance high loads and poor facilities. The research highlighted preventive and safety measures with varied implementations. The review highlighted solutions such as continuous training, organizational support, and

investment in safety infrastructure. Through such efforts, evidence-based interventions are promoted by healthcare institutions, reducing the risk and safeguarding the health care professional and ultimately ensuring overall chemotherapy handling practice safety.

### Limitations

This study has several limitations. The study relies on secondary data from existing literature, which may include biases created by study design variability, publication bias, and inconsistent methodologies across sources. The generalizability of results may also be limited by regional differences in healthcare infrastructure and practices, given that this study synthesizes findings from diverse settings.

### Recommendations

Longitudinal studies in the future should be conducted to assess the long-term impact of training programs and interventions, especially in low resource settings. Large-scale multicenter studies may also be designed to examine the effectiveness of standardized safety protocols and advanced protective technologies such as closed system drug transfer devices. This would include investing in innovative solutions, enhancing the organizational safety culture, and integrating technology-driven training programs for advancing the safety and well-being of healthcare professionals handling chemotherapy drugs.

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