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Original Article

Compliance with Chemotherapy Safety Standards Among Nurses

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Abstract

Background: Many chemotherapeutic agents are classified as carcinogenic substances, placing nurses—who are often in close contact with these agents—at significant risk of exposure. This study aimed to evaluate the extent of compliance with chemotherapy safety standards among nurses working in teaching hospitals affiliated with Iran University of Medical Sciences.

Methods: This descriptive cross-sectional study employed a census sampling method and included 110 nurses working in chemotherapy units of hospitals affiliated with Iran University of Medical Sciences. Data were collected using four questionnaires addressing nurses' demographic characteristics, performance, knowledge levels, and attitudes. The attitude assessment encompassed dimensions of self-efficacy, perceived occupational barriers, risk perception, and workplace safety.

Results: The mean age of the participants was 31.5 ± 5.93 years. Most of the participants were female (71.8%) and held a bachelor's degree (70%). The mean total performance score was 93.4 ± 7.58. Mean knowledge scores were 7.38 ± 2.38 for exposure to chemotherapy agents and 4.8 ± 2.13 for awareness of side effects—both indicating a moderate level of knowledge. The mean scores for self-efficacy, occupational barriers, risk perception, and workplace safety were 15.99 ± 2.06, 21.7 ± 3.72, 5.76 ± 1.64, and 39.17 ± 4.11, respectively.

Conclusion: The nurses in this study exhibited an acceptable level of knowledge and performance in adhering to standard chemotherapy safety protocols. However, to further enhance workplace safety and reduce occupational risks, continuous training initiatives focused on increasing awareness of chemotherapy-related hazards and adverse effects are strongly recommended.

Keywords: Chemotherapy drugs, Nurses, Safety principles, Knowledge, Standard protocols

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Introduction

Cancer remains one of the leading causes of mortality worldwide (1), and chemotherapy continues to be one of the most effective therapeutic approaches for managing the disease. However, the preparation, handling, and administration of chemotherapeutic agents pose significant occupational hazards—not only to patients but also to healthcare professionals, particularly nurses working in chemotherapy units. Prolonged exposure to chemotherapeutic agents, especially among nurses involved in their preparation and administration, has been linked to carcinogenic effects and genotoxicity (2).

Ensuring the safe handling of chemotherapy drugs necessitates strict adherence to established safety protocols. These protocols include accurate and precise drug preparation, rigorous compliance with hygiene standards, and the safe segregation and disposal of hazardous waste. Nurses administering chemotherapy are expected to observe these guidelines meticulously. Standard procedures encompass the use of personal protective equipment (PPE) during drug preparation and administration, adherence to safe handling practices in drug compounding, and the proper disposal of cytotoxic materials. Moreover, maintaining a safe and controlled environment in areas designated for chemotherapy drug preparation is essential. Non-compliance with these standards can result in hazardous occupational exposures, potentially leading to a range of acute and chronic health consequences affecting multiple organ systems (2).

The adverse effects of occupational exposure to chemotherapy drugs are well-documented in the literature. Acute manifestations may include contact dermatitis, localized and systemic skin reactions, gastrointestinal disturbances (e.g., abdominal pain, nausea, vomiting, diarrhea), headaches, dizziness, hair loss, liver toxicity, respiratory symptoms (e.g., cough, throat irritation), allergic reactions, and ocular injuries (3, 4). Furthermore, several studies have identified reproductive health risks associated with such exposure, including infertility, spontaneous abortion, fetal malformations, and recurrent

pregnancy loss (5). Alarmingly, there have also been reports of congenital anomalies in children born to nurses exposed to chemotherapy agents during pregnancy. In addition, the presence of mutagenic compounds has been detected in the urine samples of exposed nurses, further highlighting the genotoxic potential of these substances (6).

Nurses play a critical role in the healthcare team, particularly in the accurate administration of medications to ensure therapeutic efficacy and minimize adverse effects. This responsibility becomes even more crucial in the context of oncology, where nurses frequently manage hazardous chemotherapeutic agents. Failure to comply with established chemotherapy safety protocols not only compromises patient safety but also exposes nurses to serious, and potentially irreversible, health risks. Such lapses may lead to prolonged treatment durations, significant financial burdens, and systemic inefficiencies within the healthcare system. For example, a study conducted in Nepal in 2012 investigated nurses' attitudes and practices concerning standard chemotherapy precautions in teaching hospitals and found that global safety standards were inadequately followed. The study also highlighted a lack of sufficient medical oversight regarding nurses' adherence to these safety protocols (7). Nonetheless, evidence suggests that training interventions can substantially enhance nurses' knowledge and awareness. Short-term educational programs focusing on core nursing practices have been shown to improve nurses' understanding and attitudes toward safe chemotherapy administration (8, 9).

Accordingly, it is essential to assess the extent to which nurses adhere to standard chemotherapy guidelines. Where gaps are identified, the implementation of ongoing, short-term training programs should be considered to bridge these deficiencies (10). To this end, the present study aims to evaluate nurses' adherence to standard chemotherapy protocols in teaching hospitals affiliated with Iran University of Medical Sciences. The findings may inform administrators and policymakers in developing targeted educational and strategic interventions, ultimately contributing to enhanced quality and accuracy in patient care delivery.

Methods

The present study employed a descriptive cross-sectional design and was conducted in 2019 in the chemotherapy departments of Firouzgar, Rasoul Akram, and Ali Asghar hospitals, all affiliated with Iran University of Medical Sciences. The primary objective was to evaluate the extent to which nurses adhere to standard chemotherapy safety guidelines. The research population comprised all nurses working in the aforementioned teaching hospitals. Specifically, the target sample consisted of nurses working in adult and pediatric hematology and chemotherapy wards, as well as in outpatient chemotherapy units within the three selected hospitals. A total of 110 chemotherapy nurses participated in the study, selected through a census sampling method. To ensure the reliability and validity of the findings, participants were selected based on predefined eligibility criteria. These criteria required that nurses hold at least a bachelor's degree in nursing or a higher academic qualification and have a minimum of six months of professional experience working with chemotherapeutic agents. To collect data relevant to the research objectives, four questionnaires were utilized. These questionnaires were developed based on a comprehensive review of relevant textbooks, peer-reviewed scientific articles, established clinical guidelines, and consultations with academic experts in the field. All questionnaires were administered in a self-report format.

The first questionnaire assessed the participants' demographic information. The second instrument measured the nurses' performance in chemotherapy units. The tool consists of 23 items designed to evaluate adherence to standard chemotherapy safety principles. These items encompass five key domains: use of personal protective equipment (PPE) during drug preparation (5 items), use of PPE during patient interaction (4 items), adherence to standard drug preparation procedures (8 items), compliance with proper disposal of chemotherapy-related waste (3 items), and attention to environmental safety in drug preparation areas (3 items). The responses to the items in the performance questionnaire are rated using a five-point Likert scale: "Always" (5 points), "Most of the time" (4 points), "Sometimes" (3 points), "Rarely" (2 points), and "Never" (1 point). The total score ranged from 23 to 115. Based on this scoring system, scores below 70 are classified as poor, scores between 70 and 94 as moderate, and scores from 95 to 115 as good. This questionnaire was revised and validated in a 2010 study conducted in the United States, where its reliability was confirmed with a Cronbach's alpha coefficient of 0.83 (11). In a 2013 study by Ahmadi et al conducted in Ahvaz, Iran, the instrument was again confirmed to be valid and reliable, with a reported Cronbach's alpha of 0.74 (4). A modified version of the questionnaire, comprising 13 items, was employed in another study by Ahmadi also in Ahvaz, and demonstrated reliability with a Cronbach's alpha coefficient of 0.75 (3).

The third questionnaire assessed nurses' knowledge using 14 items. Items 1 through 13 evaluate knowledge about exposure to chemotherapy drugs. Each correct response is awarded one point, while incorrect answers and "I don't know" responses receive zero. The maximum possible score for these items is 13. Scores from 0 to 5 are considered poor, 6 to 10 as moderate, and 11 to 13 as good. Item 14 assesses awareness of chemotherapy drug side effects and lists nine common adverse effects. One point is assigned for each correctly identified side effect, resulting in a maximum score of 9. A score of 0 to 3 is

considered poor, 4 to 6 moderate, and 7 to 9 good. This scoring scheme was derived from a study by Ahmadi et al (2013) (4).

The fourth questionnaire examined nurses' attitudes and comprised four sections (3). The instrument consists of four items measuring self-efficacy, nine items assessing perceived occupational barriers, three items evaluating perceived risks of chemotherapy drug exposure, and nine items assessing workplace safety. The responses are rated on a five-point Likert scale: "Strongly agree" (5 points), "Agree" (4 points), "Neutral" (3 points), "Disagree" (2 points), and "Strongly disagree" (1 point). In the self-efficacy and workplace safety sections, higher scores indicate more positive perceptions. In the occupational barriers section, higher scores reflect greater perceived barriers, while in the risk perception section, lower scores indicate a better understanding of the associated risks. This attitude questionnaire was employed in a study by Ahmadi et al (2015), where its validity and reliability were confirmed. The Cronbach's alpha coefficients were 0.81 for self-efficacy, 0.78 for occupational barriers, 0.86 for risk perception, and 0.80 for workplace safety (3).

The reliability of the questionnaires was assessed using Cronbach's alpha coefficient in a pilot study on 15 nurses randomly selected from the research population. Notably, these nurses also participated in the main study. The estimated Cronbach's alpha values were 0.80 for the self-efficacy questionnaire, 0.76 for occupational barriers, 0.84 for perceived risks, 0.82 for workplace safety, 0.75 for the knowledge assessment, and 0.76 for the performance questionnaire. Data collection was carried out during nurses' work shifts by distributing the questionnaires at their break times.

Data Analysis

The collected data were analyzed via SPSS software using descriptive and inferential statistics. In the descriptive statistics section, frequency distribution tables were used for qualitative variables, while numerical indices including minimum, maximum, mean, and standard deviation were applied for quantitative variables.

Ethical Considerations

- Ethical approval for this study was obtained from the Ethics Committee of Iran University of Medical Sciences (Approval code: IR.IUMS.REC.1398.186).
- The researcher adhered fully to ethical principles and maintained integrity in the use of all referenced studies and sources.
- The objectives, methodology, and procedures of the study were thoroughly explained to all participants, and written informed consent was obtained before their participation.
- The participants' questions regarding the study were addressed comprehensively and transparently.
- Confidentiality of all information collected from participants was assured and strictly maintained throughout the study.
- Demographic information forms were kept anonymous, and data were used exclusively for this study.
- The participants were informed of their right to freely enter or withdraw from the study at any time.
- The study results were reported accurately and truthfully.
- Research findings were made available to participants and relevant authorities within the study setting upon request.
- Honesty and rigor were upheld in all stages of the research process, including sampling, data collection, and data analysis.

Results

The mean age of the participants was 31.5 ± 5.93 years. The majority of participants in this study were female (71.8%). Moreover, 53.6% of the participants were single. Most participants held a bachelor's degree (70.0%), while only 33 individuals (30.0%) had a degree higher than a bachelor's. The participants' demographic characteristics are presented in Table 1:

The data in Table 2 indicate that the awareness of the modes of exposure to medications was poor in 19.1% of nurses, and awareness of the side effects of medications was poor in 32.7% of nurses.

As shown in Table 3, the domain of adherence to standards for medication preparation had the highest mean score, while the domain of compliance with standard drug waste disposal procedures had the lowest mean score among the performance-related domains. Besides, the overall mean performance score of nurses was 93.4 ± 7.58, which was higher than the instrument's median score of 69.

The assessment of nurses' attitudes toward adherence to chemotherapy drug guidelines in teaching hospitals affiliated with Iran University of Medical Sciences is presented in Table 4. The mean self-efficacy score was 15.99 ± 2.06, the mean score for perceived occupational barriers was 21.7 ± 3.72, the mean score for risk perception

Table 1. The participants' demographic characteristics

	Demographic variables	Frequency	Percentage
Total		110	100
Gender	female	79	71.8
	Male	31	28.2
Marital status	single	59	53.6
	Married	51	46.4
Education	bachelor's degree	77	70
	Master's degree or higher	33	30
	Age (mean ± SD)	31.5 ± 5.93	

Table 2. Descriptive statistics for nurses' awareness of compliance with standard chemotherapy guidelines

Awareness	Mean	SD	Min	Max	Poor awareness N (%)	Moderate awareness N(%)	Good awareness N (%)
Awareness of modes of exposure to medications (Range: 0–13)	7.38	2.38	0	12	21 (19.1%)	80 (72.7%)	9 (8.2%)
Awareness of side effects of medications (Range: 0–9)	4.8	2.13	0	9	36 (32.7%)	44 (40%)	30 (27.7%)

Table 3. Descriptive statistics for nurses' performance and its domains in compliance with standard chemotherapy guidelines

Performance Domains	Mean	SD	Poor performance N (%)	Moderate performance N (%)	Good performance N (%)
Use of PPE while handling chemotherapy drugs (Range: 5–25)	20.05	2.53	12 (11.0)	38 (34.5)	60 (54.5)
Use of PPE when in contact with chemotherapy patients (Range: 4–20)	16.30	1.88	16 (14.6)	41 (37.2)	53 (48.2)
Adherence to medication preparation protocols (Range: 8–40)	32.67	4.14	8 (7.3)	19 (17.3)	83 (75.4)
Compliance with standard drug waste disposal procedures (Range: 3–15)	12.14	1.89	17 (15.5)	38 (34.5)	55 (50.0)
Observance of safety measures in the drug preparation environment (Range: 3–15)	12.23	2.08	11 (10.0)	23 (20.9)	76 (69.1)

was 5.76 ± 1.64, and the mean score for perceived workplace safety was 39.17 ± 4.11.

Discussion

The analysis of nurses' adherence to standard chemotherapy safety guidelines demonstrated an overall good level of performance, with a mean score of 93.4 ± 7.58. Regarding nurses' knowledge, the mean score for awareness of exposure routes to chemotherapy drugs was 7.38 ± 2.38, while the mean score for awareness of chemotherapy drug side effects was 4.8 ± 2.13; both scores fall within the moderate range. The mean scores for attitude domains were as follows: self-efficacy: 15.99 ± 2.06; perceived occupational barriers: 21.7 ± 3.72; risk perception: 5.76 ± 1.64; and perceived workplace safety: 39.17 ± 4.11.

The assessment of nurses' compliance with chemotherapy safety standards confirmed a generally good level of adherence (93.4 ± 7.58). Nevertheless, evidence from multiple studies indicates that although the majority of nurses routinely use gloves when handling chemotherapy drugs, the use of protective gowns is considerably less frequent (3,4,11). For example, Polovich and Martin reported that only 15% of nurses wore gowns during chemotherapy drug handling, and merely 13.0% wore gowns when in contact with patients (11). Similarly, a study conducted by Nwagbo et al reported that 27.0% of nurses used gowns while working with chemotherapy drugs, whereas only 7.0% did so when in contact with patients (8). Martin and Larson found that although glove use was reported by 99.0% of nurses during chemotherapy drug handling and by 94.0% during patient contact, gown use was substantially lower—53.0% during drug handling and 31.0% during patient contact (12). In the present study, gown usage was reported by 39.1% of nurses while handling chemotherapy drugs by 33.6% of nurses when contacting patients.

An assessment of the nurses' knowledge of standard chemotherapy safety guidelines indicated that the nurses' awareness of exposure routes to chemotherapy drugs and their knowledge of drug side effects were both within the moderate range. Only 8.2% of participants demonstrated a good level of knowledge about exposure routes, while 27.3% exhibited good knowledge of chemotherapy drug side effects. This overall insufficiency in knowledge about adverse effects is concerning, as it may increase the likelihood of unsafe behaviors among nurses. Awareness of the side effects of chemotherapy medications is critical because it contributes to risk perception—a cognitive process through which individuals evaluate the severity of a threat or hazard (4,11).

The findings concerning nurses' attitudes toward adherence to standard chemotherapy safety protocols revealed that the mean self-efficacy score was 15.99 ± 2.06, the mean perceived occupational barriers score was 21.7 ± 3.72, the mean risk perception score was 5.76 ± 1.64, and the mean workplace safety score was 39.17 ± 4.11. These findings are consistent with the results reported by Ahmadi et al (3), who found that nurses demonstrated high levels of self-efficacy and a good awareness of the risks associated with handling chemotherapy drugs. Ahmadi et al reported poor adherence to safety principles among nurses (3), whereas in the present study, adherence to personal protective measures was assessed as moderate. Similarly, Polovich and Clark reported that although nurses exhibited high self-efficacy and a sound understanding of occupational risks, the actual use of PPE remained low—as confirmed by Ahmadi et al (3,13). In contrast, the present study found that nurses achieved relatively high scores in PPE use, both during the handling of chemotherapy drugs and while interacting with patients undergoing chemotherapy treatment. When examining perceived barriers to adherence, the most frequently reported obstacles in the present study were a perceived lack of necessity, shortage of equipment, and the high cost of PPE. In contrast, other studies have

Table 4. Descriptive statistics for attitude and its domains regarding compliance with standard chemotherapy guidelines

Attitude Domains	Mean	Standard deviation	Poor attitude N (%)	Moderate attitude N (%)	Good attitude N (%)
Self-Efficacy (Range: 4–20) *(Higher scores indicate better self-efficacy)*	15.99	2.06	16 (14.5)	63 (57.3)	31 (28.2)
Occupational Barriers (Range: 9–45) *(Higher scores indicate more barriers)*	21.70	3.72	53 (48.1)	29 (26.6)	28 (25.3)
Risk Perception (Range: 3–15) *(Lower scores indicate better risk perception)*	5.76	1.64	8 (7.2)	19 (17.3)	83 (75.5)
Perceived Workplace Safety (Range: 5–50) *(Higher scores indicate better safety perception)*	39.17	4.11	48 (43.6)	36 (32.8)	26 (23.6)

identified lack of time, high patient loads, excessive workload, understaffing, and equipment shortages as the primary barriers to safe practice (3,13). Chaudhary and Karn further highlighted the absence of a safe working environment and insufficient protective equipment as critical factors contributing to non-compliance with safety protocols during chemotherapy drug handling. Their findings underscored the importance of improving the work environment and ensuring the consistent availability of protective equipment (7). It is important to note that providing appropriate protective equipment for handling chemotherapy agents is the responsibility of employers. Adequate supplies must be made available, and staff should be encouraged to use them consistently. Moreover, healthcare managers must consider that increasing nurses' workloads jeopardizes both the quality of patient care and the health and safety of nursing staff. In the present study, high scores were observed for items related to administrative efforts aimed at reducing occupational risks and addressing unsafe practices, indicating that management is effectively fulfilling its role and contributing to a safer work environment. Conversely, these factors received lower scores in Ahmadi et al's study (3).

One limitation of the present study was the relatively small sample size. Although 110 nurses attended the study, a larger sample could enhance the reliability and generalizability of the findings. Furthermore, data were collected using self-report instruments, which introduced the potential for response bias. The participants may have provided socially desirable answers rather than accurately reflecting their actual practices and attitudes. Nonetheless, it is important to note that similar studies have utilized the same self-report methodology (3,11,13).

Conclusion

This study investigated nurses' adherence to chemotherapy safety standards in teaching hospitals affiliated with Iran University of Medical Sciences in 2019. The findings indicated that overall nurse performance was rated as good, with particularly strong compliance in the use of personal protective equipment (PPE) and adherence to drug preparation standards. Based on these findings, it is imperative to implement ongoing and regular training programs aimed at increasing nurses' awareness of the risks and side effects associated with chemotherapy drugs. Improving nurse adherence to safety guidelines also requires addressing critical barriers such as perceived lack of necessity, equipment shortages and costs, time constraints, high workload, and imbalances in staff-to-patient ratios. The insights from this study can inform nurses, nurse supervisors, nursing managers, training coordinators, and human resource planners. Ultimately, these findings support the development of enhanced training programs, reinforcement of safety protocol adherence, and improvement of nurses' knowledge, attitudes, and overall performance.

Authors' Contribution

Conceptualization and design: Masood Dayani, Fatemeh Mohaddes Ardebili.
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Writing – review & editing: Masood Dayani, Tahereh Najafi Ghezeljeh.

Ethical Approval

This study has the approval of Iran University of Medical Sciences Ethics Committee number IR.IUMS.REC.1398.186.

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