Safe Handling of Oral Chemotherapeutic Agents Among Nurses in Oncology Units

Diana S. Lalithabai, BahaAldeen T. Mahmood, Heba J. Salamah

***Abstract*- Background: Several concerns have been raised in the literature regarding nurses' awareness of the safe handling of oral chemotherapeutic agents (OACAs). This research aims to assess such awareness among nurses working in oncology units.**

Methods: The study utilised a cross-sectional descriptive design, and was conducted between July 2022 and March 2023. Data were collected via a structured questionnaire from a previous study, with 34 variables grouped into four categories.

Results: Our study indicated that most nurses knew how to safely handle chemotherapeutic drugs. Correct responses per category were: storage, 77.7%; handling, 65.86%; disposal of contaminated materials, 94.45%; and education and training, 89.68%. Nurses with > 10 years' experience had higher scores than those with < 10 years; the difference was significant (p = 0.039). Likewise, there was a significant difference (p = 0.002) in mean scores between nurses who had received training on the safe handling of chemotherapeutic drugs (92.1 ± 20) and those who had not (76.8 ± 30.7).

Conclusion: The study indicates that years of experience and roles at work have a significant impact on nurses' knowledge about the storage of chemotherapeutic drugs. Overall, nurses with more experience and training scored significantly higher, suggesting that training is an effective way to improve knowledge and skills in this area. Furthermore, participation in this study might influence might influence nurses' judgments when handling oral chemotherapeutic drugs and caring for cancer patients.

***Index Terms*— Awareness, Cancer, Nurses, Oral Chemotherapeutic Agents, Safe Handling**

I. INTRODUCTION

In the past 30 years, cancers and non-communicable diseases have surpassed infectious diseases as the primary cause of death. Globally, there were 17 million new cancer cases and 9.6 million cancer deaths [1,2]. In 2019, 20 043 new cancer cases were reported to the Saudi Cancer Registry (SCR), with women (55.3%; N = 11 087) affected more than men (44.7%; N = 8 956) [3]. In Saudi Arabia, the incidence and prevalence of cancer are expected to triple by 2030, driving up healthcare expenses and creating a financial burden on the country [4].

Cancer therapy involves the use of chemotherapeutic drugs that have cytotoxic properties [5]. So severe are their potential side effects that there has been a great deal of focus on patients' immune systems and their activation via biological therapies [6]. With regard to healthcare providers, the high patient load and extensive use of chemotherapeutic agents raises concerns about the potential hazards of these agents for this cohort. During the 1970s, evidence highlighted the risk of adverse effects from antineoplastic drugs on healthcare workers due to occupational exposure. Since then, reports from several countries have documented drug contamination in the workplace and measured genotoxic responses in workers [7]. Due to inadequate control measures, oncology healthcare workers have faced the danger of exposure to antineoplastic drugs and experienced acute adverse health effects [8].

Diana S. Lalithabai, is with the Nursing Education Administration, King Fahd Medical City, Riyadh, Kingdom of Saudi Arabia, email: dlalithabai@kfmc.med.sa. BahaAldeen T. Mahmood, is with the Anderson Cancer Center, The University of Texas, Houston, United States, email: bahamahmood11@gmail.com. Heba J. Salamah, is with the Clinical Pharmacy Department, King Fahd Medical City, Riyadh, Kingdom of Saudi Arabia, email: hsalamah@kfmc.med.sa.
DOI: 10.52609/jmlph.v4i2.109

Occupational exposure of employees and those around them is directly impacted by how well they carry out their tasks. Employees must meet the most recent requirements for working practices and be aware of the workplace hazards presented by these substances [9]. Despite safe handling guidance, however, recommended practices are not always followed, [10] and nurses' skills and experience in the safe handling of cytotoxic medicines are often insufficient [11].

In addition, it is still necessary to fully address the occupational hazards for healthcare workers who handle these drugs in the course of their duties. Due to their involvement in administering oral chemotherapy drugs, nurses are at particular risk. Hence, this study aimed to assess awareness surrounding the safe handling of oral chemotherapeutic agents among nurses working in oncology units. Furthermore, it investigated the relationship between the nurses' demographic characteristics and their safety practices when handling such agents.

II. LITERATURE REVIEW

While there are dangers associated with numerous therapeutic groups of oral medications, the majority of oral chemotherapy drugs are dangerous due to their modes of action [12]. A study to identify potential exposures to antineoplastic drugs and factors influencing safety behavior reported that chemical residue from antineoplastic drugs was found in the workplace, and the low use of personal protective equipment (PPE) indicated potential exposure [13]. Another study gauging the frequency and distribution of workplace exposure to anticancer agents found that most employees (75%) fall within the moderate exposure category [14]; yet another found surface contamination [15].

Facilities in low-income countries reported lower median safety practices than those in middle-income countries. There exist large variability and significant gaps in the safe handling of chemotherapy agents; the most significant differences can be attributed to personnel, the preparation process, and incident management [16]. The use of recommended engineering controls and PPE varied among settings, and was better in non-profit and government settings [17]. No matter how much experience nurses have with chemotherapy, it is recommended that they regularly refresh their expertise and knowledge of rules, to guarantee that relevant guidelines are applied [18].

Some literature found that nurses' knowledge of chemotherapy and handling of chemotherapeutic agents was inadequate [19]. Few researchers have confirmed that nurses' knowledge of handling drugs is acceptable, [20] and the knowledge and expertise of nurses regarding the proper management of cytotoxic medications were lacking when delivering routine care in cancer wards [21]. A study in Saudi Arabia, which included four hospitals in the Riyadh region, demonstrated a lack of knowledge among healthcare professionals, including oncology nurses [22].

Despite possessing extensive knowledge about exposure risks, oncology nurses face barriers to the adoption of personal protective practices. These include challenges in using personal protective equipment (PPE) and conflicts of interest, which hinder the widespread implementation of such safety measures [23, 24]. The research found scant information about the education of chemotherapy nurses or their safety requirements [25]. One study highlighted that, even if nurses' knowledge, attitude and practice scores regarding the safe handling of chemotherapy drugs (CDs) were inadequate, the use of personal protective equipment (PPE) during the various steps of CD handling was noted [26]. In some settings, the availability of the special treatment room was absent; the nurses did not use special PPE and were ignorant about the importance of medical checkups, and none underwent through regular medical checkups [27]. Concerning safe handling precautions, most participants rarely used eye protection [28,29]. Wearing PPE was seen as an obstacle to professional image and performance: nurses compromised safety for efficiency and prioritised social roles over professional ones. Experienced nurses believed that, as insiders, they had sufficient clinical wisdom to avoid occupational

exposure to chemotherapy toxicity [30].

Though adherence to safe handling practices can substantially reduce potential exposure for healthcare workers, several workplace factors affect such handling [31]; in particular, the workplace safety atmosphere, work environment, and oncology nursing experience [32].

Despite the lack of guidelines for acceptable or allowable surface concentrations of these drugs in the healthcare setting, wipe sampling as a screening tool can be part of a comprehensive safe-handling program to assess and reduce environmental contamination by antineoplastic drugs [33]. Furthermore, compared with ordinary devices, a closed-system transfer device can significantly lower the chemical contamination of barrier isolators, even though it does not entirely eliminate contamination [34].

USP Chapter 800, a legally binding standard, outlines standards for limiting occupational exposure in healthcare workers and insists that hospitals, clinics, and all locations where Hazardous drugs (HDs) are produced or administered, and where medical staff may come into contact with HD residue, must adhere to these guidelines [35]. Healthcare professionals must use their professional judgment, expertise, and common sense when applying these principles, taking into account the standards of any applicable accrediting organisations and changing federal, state, and local legislation [36].

Some of the major issues identified with regard to the safe management of antineoplastic medications (oral, parenteral, or intrathecal) were associated with the prescription, preparation, distribution and administration thereof [37-39]. As oncology nurses and others are entrusted to assist with patient care, [40] ongoing evaluation of the workplace is necessary to foster a climate of safety and create a culture that supports the wellness of nurses, their patients, and the general public [41].

Safe handling protects healthcare professionals (HCPs); nonetheless, the above reviews raise severe concerns about nurses' knowledge and safe handling of chemotherapeutic agents. While there have been several studies on the topic, oral chemotherapy medications are rarely the focus of the literature, which focuses on chemotherapeutic drugs in general. This significant knowledge gap leaves the question as to whether nurses can safely handle oral chemotherapeutic medications, which pose a risk to both nurses and patients.

III. METHODOLOGY

Study design:

The study utilised a cross-sectional descriptive design, and was carried out between July 2022 and March 2023.

Setting and participants:

Participants were recruited from a tertiary healthcare setting in Riyadh, KSA. One hundred and seventy-three nurses worked in the oncology units within this setting, providing care for cancer patients. Using the purposive sampling technique, 120 of these were selected to participate in the study. Included were those nurses working in the oncology wing who handled chemotherapeutic drugs or agents, were willing to participate in the survey, and were fluent in English. Nurses who did not handle chemotherapeutic agents and those not directly involved in patient care were excluded.

Sample size:

We used another study as a reference to estimate the sample size for this study [21], with a 72.6% prevalence of safe handling for oral chemotherapeutic agents, a finite population correction was applied to the total nurse population of 173 (working in oncology units).

Data collection:

Data were collected by a research assistant, using a self-administered, structured questionnaire from a previous study [34]. Written permission was obtained from the author to use the questionnaire. This tool consists of five sections: (1) Demographic data; (2) Storage, which includes four items; (3) Handling, which includes 21 items; (4) Disposal and cleaning of contaminated materials, which includes three items; and (5) Training and education, which includes five items. The three options for response were 'yes', 'not sure', and 'no', with 'yes' considered the correct option except for items 4, 8,

E-mail: dlalithabai@kfmc.med.sa

24, 25, and 26, where 'no' was the correct answer. All responses were expressed in percentages.

Ethical considerations:

This study was reviewed and approved by the Institutional Review Board (IRB), with IRB Log no. 22-264, and followed the guidelines of the Declaration of Helsinki. Before enrollment, researchers explained to participants the purpose of the research, and that participation in the survey was voluntary. Furthermore, all participants were informed about anonymity, confidentiality, and the option of voluntary termination at any time.

Statistical analysis:

Data was analysed using statistical software SPSS version 25.0 (IBM, Armonk, NY, USA). The questionnaire included 34 variables, grouped into four sections: storage; handling; disposal and cleaning of contaminated materials; and education and training. The correct answers for each section were totaled, and their mean converted into percentage scores. The association between socio-demographics and the four aspects of safe handling was measured using a Chi-square test, while the least significant difference between percentage mean scores and socio-demographics was measured using the Mann Whitney U test and the Kruskal Wallis H test, as applicable. A 95% confidence interval was applied.

IV. RESULTS

Demographic data:

The questionnaire was distributed to 120 participants, and the response rate was 100%. The majority of participants were female, 110 (91.7%); and registered nurses, 105 (87.5%). Most of the nurses, 101 (84.2), had received training on the safe handling of chemotherapy drugs. The participants' demographic characteristics are summarised in Table 1.

Safe handling procedures for oral anticancer agents (OACAs):

Table 2 illustrates the responses of the 120 certified nurses in this study with regard to safe handling procedures for oral anticancer agents (OACAs). The correct response response rate per category was: storage, 77.7%; handling, 65.86%; disposal of contaminated materials, 94.45%; and education and training, 89.68%.

Association between safe handling practices and demographic variables:

Tables 3a-3d compare the participants' safe handling scores with their demographic and professional characteristics. The scores indicate that nurses' years of experience and their positions at work have a significant influence on their knowledge regarding storage. Nurses with fewer than two years' experience had significantly less storage knowledge than those in other experience intervals ($p=0.002$). Furthermore, the scores of charge nurses and unit managers were higher than those of registered nurses ($p=0.078$), and nurses who had received training had significantly greater storage knowledge than those who had not ($p=0.029$).

Females' handling scores were significantly higher than males' ($p = 0.040$). Moreover, nurses with > 10 years' experience had higher scores than those with < 10 years; the difference was significant ($p = 0.039$). Increasing years of experience in an oncology unit had a direct bearing on scores in the category of disposal of contaminated waste ($p = 0.030$).

Nurses who had received training on the safe handling of chemotherapy drugs had a higher mean score (92.1 ± 20) than those who had not (76.8 ± 30.7); the difference was significant ($p= 0.002$). This suggests that training is an effective way to improve nurses' knowledge and skills in this area.

V. DISCUSSION

The issue of medication safety is particularly significant in the case of anticancer therapies, due to the high potential for harm posed by these agents and the disease context in which they are used [39]. Guidelines exist that recommend safe prescribing, dispensing, and administration of chemotherapy and related agents used in cancer treatment, [41] and standard guidelines education improves knowledge and performance with regard to safe handling

E-mail: dlalithabai@kfmc.med.sa

Table 1. Sociodemographic Characteristics of Participants

Characteristic	Description	N (%)
Gender	Male	10 (8.3)
	Female	110 (91.7)
Years of nursing experience	< 2	7 (5.8)
	2 - 5	18 (15.0)
	6 - 10	45 (37.5)
	> 10	50 (41.7)
Years of experience in oncology unit	< 2	27 (22.5)
	2 - 5	49 (40.8)
	6 - 10	20 (16.7)
	> 10	24 (20.0)
Nursing educational level	Diploma	29 (24.2)
	BSN	91 (75.8)
	MSN	0 (0)
	PhD	0 (0)
Position	Registered nurse	105 (87.5)
	Charge nurse	6 (5.0)
	Unit manager	9 (7.5)
Received training on the safe handling of chemotherapeutic agents	Yes	101 (84.2)
	No	19 (15.8)

Table 2. Participants' Handling of Oral Chemotherapeutic Agents

Items	Yes	No	Not sure
Section B: Storage of OACAs			
1. We ensure proper storage and handling of OACAs to prevent accidental exposure and to ensure their integrity.	117 (97.5)	0 (0)	3 (2.5)
2. We store OACAs in a designated area as per the manufacturer's instructions and separate them from non-chemotherapeutic agents.	111 (92.5)	6 (5.0)	3 (2.5)
3. We follow storage specifications for OACAs that are air, moisture, and/or light-sensitive.	112 (93.3)	3 (2.5)	5 (4.2)
4. We store OACAs in alphabetical order with other non-chemotherapeutic drugs.	80 (66.7)	33 (27.5)	7 (5.83)
Section C: Handling of OACAs			
5. We have a hospital-wide policy regarding the handling and administration of ACAs.	119 (99.2)	1 (.8)	0 (0)
6. We have a hospital-wide policy regarding the handling and administration of OACAs.	118 (98.3)	1 (.8)	1 (.8)

E-mail: dlalithabai@kfmc.med.sa

7. The risk of harm from handling OACAs is equal to that from injectable chemotherapy agents.	103 (85.8)	8 (6.7)	9 (7.5)
8. We handle and administer OACAs without precautions.	48 (40.0)	65 (54.2)	7 (5.8)
9. OACAs should be handled with the same precautions recommended for intravenous chemotherapy.	107 (89.2)	8 (6.7)	5 (4.2)
10. We limit the handling and administration of OACAs to qualified, trained personnel.	112 (93.3)	5 (4.2)	3 (2.5)
11. Doses of oral chemotherapeutic agents in liquid form are required to be dispensed in a single-dose oral syringe.	111 (92.5)	4 (3.3)	5 (4.2)
12. Oral chemotherapeutic agents are considered "High Alert Drugs".	111 (92.5)	6 (5.0)	3 (2.5)
13. Containers for OACAs should have a label with special handling precautions.	113 (94.2)	2 (1.7)	5 (4.2)
14. Caution labels should be available in the OACA dispensing area.	114 (95.0)	1 (.8)	5 (4.2)
15. We have a "spill kit" available in all areas dealing with OACAs.	105 (87.5)	6 (5.0)	9 (7.5)
16. The package label of OACAs should indicate that the agent is cytotoxic.	119 (99.2)	0 (0)	1 (.8)
17. Proper use of personal protective clothing and equipment should be instituted to minimise exposure and health risks.	114 (95.0)	4 (3.3)	2 (1.7)
18. We do not dispense OACAs using automatic counting machines.	96 (80.0)	9 (7.5)	15 (12.5)
19. We use disposable gloves when dispensing OACAs.	100 (83.3)	6 (5.0)	14 (11.7)
20. We perform OACA manipulations such as compounding, crushing, cutting, or splitting in a biological safety cabinets or isolators, and we use disposable personal protective equipment.	80 (66.7)	33 (27.5)	7 (5.8)
21. We use separate equipment for OACAs.	85 (70.8)	21 (17.5)	14 (11.7)
22. We have a written emergency plan in the event of a spill or accidental exposure to OACAs.	106 (88.3)	7 (5.8)	7 (5.8)
23. We have an updated list of hazardous medications, which is readily accessible to all healthcare personnel involved in handling OACAs.	115 (95.8)	2 (1.7)	3 (2.5)
24. We accept telephone orders for OACAs to be taken by nursing personnel	42 (35.0)	65 (54.2)	13 (10.8)
25. If non-oncology nurses are permitted to administer OACAs, special training is provided regarding the administration and handling thereof.	88 (73.3)	19 (15.8)	13 (10.8)

26. All chemotherapy orders, including oral chemotherapeutic agents, are reviewed by a pharmacist specialised in oncology.	113 (94.2)	0 (0)	7 (5.8)
Section D: Disposal and Cleaning of Contaminated Materials			
27. All disposable materials used while handling OACAs are disposed of as chemotherapy waste, according to the local waste disposal guidelines.	114 (95.0)	5 (4.2)	1 (.8)
28. All non-disposable materials exposed to oral chemotherapeutic agents, including counting trays, tools, surfaces, etc., are washed or decontaminated thoroughly after use.	112 (93.3)	4 (3.3)	4 (3.3)
29. Packaging and supplies for OACAs are disposed of in specially designated chemotherapy buckets.	114 (95.0)	1 (.8)	5 (4.2)
Section E: Education and Training			
30. We attend orientation programs and routine training courses specific to the handling of ACAs, including OACAs.	110 (91.7)	7 (5.8)	3 (2.5)
31. We have an educational program within the institution about the handling of ACAs.	110 (91.7)	4 (3.3)	6 (5.0)
32. Healthcare workers involved in handling OACAs are trained and competent to treat individuals accidentally exposed to chemotherapeutic agents, and on the disposal of ACAs.	109 (90.8)	4 (3.3)	7 (5.8)
33. We receive regular, continuous education about the safe handling and administration of ACAs in our institution.	104 (86.7)	7 (5.8)	9 (7.5)
34. Educational material about the safe handling of OACAs is available in the related areas.	105 (87.5)	5 (4.2)	10 (8.3)

Table 3a. Association between awareness of correct storage (cumulative percentage mean score) and demographic variables

Characteristic	Description	Min - Max	Mean ± SD	p-value
Gender	Male	0 - 100	70.0 ± 28.4	0.387
	Female	25 - 100	78.4 ± 15.3	
Years of nursing experience	< 2	50 - 75	64.3 ± 13.4	0.002
	2 - 5	50 - 100	81.9 ± 14.4	
	6 -10	25 - 100	75.0 ± 11.9	
	> 10	0 - 100	80.5 ± 20.4	
Years of experience in oncology unit	< 2	25 - 100	73.1 ± 15.4	0.103
	2 - 5	25 - 100	78.6 ± 13.5	
	6 - 10	50 - 100	78.8 ± 12.2	
	> 10	0 - 100	80.2 ± 25.5	
Nursing education	Diploma	25 - 100	74.1 ± 18.3	0.200

	BSN	0 - 100	78.8 ± 16.2	
Position	Registered Nurse	0 - 100	76.4 ± 16.9	0.078
	Charge Nurse	75 - 100	87.5 ± 13.7	
	Unit Manager	75 - 100	86.1 ± 13.2	
Trained on safe handling of chemotherapy drugs	Yes	0 - 100	78.7 ± 17.5	0.029
	No	50 - 100	72.4 ± 11.5	

Table 3b. Association between awareness of safe handling (cumulative percentage mean score) and demographic variables

Characteristic	Description	Min - Max	Mean ± SD	p-value
Gender	Male	36 - 91	70 ± 16.3	0.040
	Female	41 - 95	79.5 ± 9.8	
Years of nursing experience	< 2	36 - 95	70.8 ± 19.4	0.039
	2 - 5	59 - 86	76 ± 8.8	
	6 - 10	41 - 91	77.8 ± 11.4	
	> 10	50 - 95	81.5 ± 8.3	
Years of experience in oncology unit	< 2	36 - 95	75.6 ± 12.9	0.395
	2 - 5	55 - 91	79.6 ± 9.3	
	6 - 10	41 - 86	78.9 ± 10.1	
	> 10	50 - 95	80.1 ± 11.2	
Nursing education	Diploma	50 - 95	76 ± 11.6	0.095
	BSN	36 - 95	79.5 ± 10.4	
Position	Registered Nurse	36 - 95	78 ± 11.1	0.066
	Charge Nurse	77 - 91	84.8 ± 4.7	
	Unit Manager	68 - 91	82.8 ± 7.1	
Trained on safe handling of chemotherapy drugs	Yes	36 - 95	78.9 ± 9.9	0.760
	No	41 - 91	77.3 ± 14.6	

Table 3c. Association between awareness of correct disposal of waste (cumulative percentage mean score) and demographic variables

Characteristic	Description	Min - Max	Mean ± SD	p-value
Gender	Male	67 - 100	96.7 ± 10.5	0.723
	Female	33 - 100	94.2 ± 15.5	
Years of nursing experience	< 2	100 - 100	100 ± 0	0.360
	2 - 5	67 - 100	92.6 ± 14.3	

	6 - 10	33 - 100	96.3 ± 12.8	
	> 10	33 - 100	92.7 ± 18.2	
Years of experience in oncology unit	< 2	33 - 100	88.9 ± 20.7	0.030
	2 - 5	67 - 100	98.6 ± 6.7	
	6 - 10	67 - 100	96.7 ± 10.3	
	> 10	33 - 100	90.3 ± 20.8	
Nursing education	Diploma	33 - 100	93.1 ± 16.4	0.439
	BSN	33 - 100	94.9 ± 14.8	
Position	Registered Nurse	33 - 100	94.3 ± 15.6	0.852
	Charge Nurse	67 - 100	94.4 ± 13.6	
	Unit Manager	67 - 100	96.3 ± 11.1	
Trained on safe handling of chemotherapy drugs	Yes	33 - 100	95.4 ± 13.4	0.242
	No	33 - 100	89.5 ± 22.4	

Table 3d. Association between education and training (cumulative percentage mean score) and demographic variables

Characteristic	**Description**	**Min - Max**	**Mean ± SD**	**p-value**
Gender	Male	0 - 100	74 ± 37.8	0.121
	Female	0 - 100	91.1 ± 20.4	
Years of nursing experience	< 2	20 - 100	71.4 ± 32.4	0.142
	2 - 5	0 - 100	86.7 ± 29.1	
	6 - 10	0 - 100	91.1 ± 21.6	
	> 10	0 - 100	92 ± 18.5	
Years of experience in oncology unit	< 2	20 - 100	88.1 ± 20.9	0.475
	2 - 5	0 - 100	88.6 ± 23.5	
	6 - 10	0 - 100	93 ± 22.7	
	> 10	0 - 100	90.8 ± 23.6	
Nursing education	Diploma	0 - 100	92.4 ± 22.3	0.175
	Bachelor of Science in Nursing	0 - 100	88.8 ± 22.7	
Position	Registered Nurse	0 - 100	88.6 ± 23.7	0.150
	Charge Nurse	100 - 100	100 ± 0	
	Unit Manager	60 - 100	95.6 ± 13.3	
Trained on safe handling of chemotherapy drugs	Yes	0 - 100	92.1 ± 20	0.002
	No	0 - 100	76.8 ± 30.7	

E-mail: dlalithabai@kfmc.med.sa

practices [19]. While chemotherapy providers have generally developed and implemented good practices around the safe delivery of intravenous chemotherapy, there remain issues associated with orally administered antineoplastics [42]. Despite exponential growth in the use of oral anticancer medications, the knowledge about these medications and guidelines for their safe handling have not kept up to date with the speed with which the medications have been applied in clinical practice. They pose severe hazards to any personnel handling them, as well as to patients and their caregivers [43]. As nurses are front-line healthcare professionals who provide direct care for patients and are involved in the handling of oral chemotherapeutic agents, they should be well versed in the safe handling practices required for such agents.

Our study indicated that most nurses were aware of the appropriate safe storage protocols and adhered to best practices. Conversely, a multi-centre study conducted in Bangladesh [26] reported that around half of the studied nurses had been exposed to chemotherapy agents, and a more significant proportion, 58.3%, were not aware of the health hazards of oral and parenteral drugs and did not use the designated treatment room.

Regarding the handling of OACAs, nearly half of the participants in our study answered that they handle and administer OACAs without precautions. In alignment with the findings of the present study, similar studies have highlighted a misconception among patients and healthcare workers that OACAs are less harmful, carry a lower exposure risk, and are safer to handle [44]. This highlights the need to improve both patients' [45] and healthcare workers' [21] understanding of the requirements for storage, handling, and safe administration of oral anticancer drugs. However, contradicting our findings, a study [28] conducted in Jordanian hospitals revealed that nurses fully complied with the safe handling requirements for OACAs.

Our study demonstrates the nurses' awareness of hospital-wide policies regarding the handling and administering of ACAs. This finding is supported by another study [18] which found that most nurses knew about the safety guidelines for administering chemotherapy. Another study revealed full compliance in all hospitals regarding the availability of policies and procedures for the safe handling of antineoplastic agents and the availability of a reporting system.

In the current study, a good percentage of the participants were confident that they performed OACA manipulations, such as compounding, crushing, cutting, or splitting, in a biological safety cabinet or isolator, and used disposable personal protective equipment. In contrast, another study conducted in Jordanian hospitals [28] reported that the participants were least compliant with working inside the biological safety cabinet (65.1%). Other studies reported the safety design of their workplace to be rather poor [49]; and, it was noted that the utilization of personal protective equipment was lower when specific safety handling procedures were not in place [17]. These contradictory findings suggest that safe practices vary according to the management's approach to safety and perceived risk, and the availability of precautionary measures in healthcare settings.

Most of the nurses in the present study were aware of the need to use personal protective clothing and equipment to minimise exposure and health risks, and the participants used gloves to dispense OACAs. Other studies contradicted these findings, [25,29] reporting that PPE was identified as an obstacle to professional image and performance, defective use of PPE during various steps of handling chemotherapy drugs, and reduced adoption of personal protective practices among oncology nurses [23,27].

Our study found that most nurses have received training on the safe handling of chemotherapy drugs and are supported at institution level with appropriate education. Studies highlight this aspect, noting that training on safe handling enhances compliance [31].

In the current study, most nurses acknowledged that all disposable materials used while handling OACAs are disposed of as chemotherapy waste according to the local waste disposal guidelines, and packaging and supplies for OACAs are disposed of in specially designated chemotherapy buckets. In

alignment with this finding, another study [28] revealed that the items with full compliance in all hospitals were the availability of policies and procedures for the safe handling of antineoplastic agents, the availability of reporting systems, and the availability of sharps containers. Contradicting the findings of this study was a study [8] that revealed that the implemented exposure controls for preparation, administration, cleaning, and waste disposal were not in line with the safe handling guidelines.

The current study found that the nurses knew about safe handling practices; this was supported by another study with similar findings [18]. Our findings revealed that nurses with higher education, those with more experience, and those who have received training were more aware of correct storage practices with regard to OACAs. Furthermore, those with more experience in the oncology unit had more awareness concerning the disposal of contaminated waste, although the difference was not statistically significant. This finding contradicted a study that reported a statistically significant difference between the practice score and the nurses' cadre [18]. Our findings suggest that gender and years of experience play a role in handling skills, with women and more experienced nurses generally performing better. Nurses with more years of experience also had significantly higher scores in the category of disposal than. Supporting this finding, another study [18] revealed that years of experience had a statistically significant association with the safe handling of chemotherapy drugs.

Overall, nurses with experience and training scored significantly higher than those without. This finding is promising since it shows that trained nurses generally understand the significance of safe handling procedures for OACAs, and suggests that training is an effective way to improve nurses' skills and knowledge in the area.

VI. STRENGTHS AND LIMITATIONS

It should be remembered that this study is based on a survey of just 120 nurses. Given the limited sample size, the results might not represent all trained nurses. Hence, caution should be exercised when generalising these results. Additionally, the study is cross-sectional and identifies associations between the variables; it cannot determine cause-and-effect relationships. Despite these drawbacks, the study offers insightful information about qualified nurses' safe handling techniques, and can guide educational and training initiatives to enhance the ability of nurses to safely handle OACAs.

VII. CONCLUSION

Our study indicates that most trained nurses adhere to safe OACA handling procedures. Nonetheless, there is space for improvement in certain areas, such as using gloves when handling OACAs and understanding the value of keeping OACAs in a well-ventilated place. Our findings revealed a high demand to improve nurses' knowledge about the safe handling of oral chemotherapeutic agents. Hospitals might offer instruction on all facets of safe handling, such as using PPE, proper disposal of OACAs, and ways to prevent unintentional exposure. Moreover, the study itself might affect nurses' judgment when caring for cancer patients and handling oral chemotherapeutic agents, by highlighting essential gaps in the management of such agents.

VIII. DECLARATION OF INTERESTS

The authors have no conflicts of interest to disclose.

IX. FUNDING

The study received funding from King Fahd Medical City, Riyadh, Kingdom of Saudi Arabia (RFA 022-010).

X. REFERENCES

1. Bray F, Ferlay J, Soerjomataram I, Siegel RL, Torre LA, Jemal A. Global cancer statistics 2018: GLOBOCAN estimates of incidence and mortality worldwide for 36 cancers in 185 countries. CA Cancer J Clin 2018; Nov;68(6):394-424. https://doi.org/10.3322/caac.21492

2. Alessy SA, AlWaheidi S. Moving cancer prevention and care forward in Saudi Arabia. J.

Cancer Policy. 2020 Dec 1;26:100250.https://doi.org/10.1016/j.jcpo.2020.100250

3. Shaito A, Posadino AM, Younes N, et al. Potential adverse effects of resveratrol: A literature review. Int. J. Mol. Sci. 2020 Mar 18;21(6):2084. https://doi.org/10.3390/ijms21062084

4. Schirrmacher V. From Chemotherapy to biological therapy: A review of novel concepts to reduce the side effects of systemic cancer treatment. Int. J. Oncol. 2019 Feb 1;54(2):407-19. https://doi.org/10.3892/ijo.2018.4661

5. Connor TH, McDiarmid MA. Preventing occupational exposures to antineoplastic drugs in health care settings. CA Cancer J Clin. 2006 Nov;56(6):354-65.https://doi.org/10.3322/canjclin.56.6.354

6. Alehashem M, Baniasadi S. Safe handling of antineoplastic drugs in the university hospitals: a descriptive survey study among oncology nurses. Int J Cancer Manag 2018 February 1;11(2): e6482.doi: 10.5812/ijcm.6482.

7. Nabhani-Gebara S. ISOPP Standards for the safe handling of cytotoxics. J. Oncol. Pharm. Pract. 2022 April 1;28(3_suppl): S1-26. https://doi.org/10.1177/10781552211070933.

8. Hosen MS, Hasan M, Saiful Islam M, Raseduzzaman MM, Tanvirul Islam M, Tazbiul Islam M. Evaluation of knowledge and practice of handling chemotherapy agents by nurses: a multicenter studies in Bangladesh. Int J Community Med Public Heal. 2019 Oct; 6:4175-80. DOI: http://dx.doi.org/10.18203/2394-6040.ijcmph20194471

9. Asefa S, Aga F, Dinegde NG, Demie TG. Knowledge and practices on the safe handling of cytotoxic drugs among oncology nurses working at tertiary teaching hospitals in Addis Ababa, Ethiopia. Drug, Healthc. Patient Saf. 2021 Mar 29:71-80.DOI https://doi.org/10.2147/DHPS.S289025

10. Johnson TM. Long-term care: safe drug handling of Oral Chemotherapy. Consult Pharm. 2017 Feb1;32(2):74-83. DOI: https://doi.org/10.4140/TCP.n.2017.74

11. Graeve CU, McGovern PM, Alexander B, Church T, Ryan A, Polovich M. Occupational exposure to antineoplastic agents: an analysis of health care workers and their environments. Workplace Health Saf. 2017 Jan;65(1):9-20.

12. Hall AL, Demers PA, Astrakianakis G, Ge C, Peters CE. Estimating national-level exposure to antineoplastic agents in the workplace: CAREX Canada findings and future research needs. Ann. Work Expo. Health. 2017 Jul 1;61(6): 656-8.doi: 10.1093/annweh/wxx042

13. Stoeva S, Marinov P. Analytical Protocol for Monitoring Workplace Surface Contamination with Capecitabine. Curr. Pharm. Anal. 2022 Jan 1;18(1):132-40. DOI: https://doi.org/10.2174/1573412917666201217164305

14.Von Grünigen S, Geissbühler A, Bonnabry P. The safe handling of chemotherapy drugs in low- and middle-income countries: An overview of practices. J. Oncol. Pharm. Pract. 2022 Mar;28(2):410-20.https://doi.org/10.1177/1078155221995539

15.DeJoy DM, Smith TD, Woldu H, Dyal MA, Steege AL, Boiano JM. Effects of organizational safety practices and perceived safety climate on PPE usage, engineering controls, and adverse events involving liquid antineoplastic drugs among nurses. J Occup Environ Hyg. 2017 July 3;14(7):485-93. https://doi.org/10.1080/15459624.2017.1285496

16. Nwagbo SE, Ilesanmi RE, Ohaeri BM, Oluwatosin AO. Knowledge of Chemotherapy and occupational safety measures among nurses in oncology units. J. Clin. 2017 July 1;14(3):131. DOI: 10.4103/jcls.jcls_88_16

17. Nouri A, Seyed Javadi M, Iranijam E, Aghamohammadi M. Improving nurses' performance in the safe handling of antineoplastic agents: a quasi-experimental study. BMC Nurs. 2021 Dec;20(1):1-

5.https://doi.org/10.1186/s12912-021-00771-4

18. Shamran HY, Ali SA. Safe handling of cytotoxic drugs practices for nurses working with patients in middle euphrates oncology teaching hospitals. Int. J. Health Sci. 20226(S1), 9118²9129.https://doi.org/10.53730/ijhs.v6nS1.7061

19. Ibrahim N, Al Mutairi M, Al Onazi M. Assessment of Oral Chemotherapeutic Agents Safe Handling Among Healthcare Professionals in Saudi Arabia. Glob J Med Therap. 2019;1(2):14-9. https://doi.org/10.46982/gjmt.2019.104

20. Ibrahim NA, Al Alwan A, Al Eid A, Al Onazi M, Al Mutairi M. Safe handling of oral chemotherapeutic agents in clinical practice at Saudi hospitals. J. Clin. Oncol. 2015 33:15_suppl, e17752

21. Callahan A, Ames NJ, Manning ML, Touchton-Leonard K, Yang L, Wallen GR. Factors influencing nurses' use of hazardous drug safe-handling precautions. InOncology nursing forum 2016 May 1 (Vol. 43, No. 3, p. 342). NIH Public Access. doi: 10.1188/16.ONF.43-03AP

22. Coyne E, Northfield S, Ash K, Brown-West L. Current evidence of education and safety requirements for the nursing administration of Chemotherapy: An integrative review. Eur J Oncol Nurs. 2019 August 1; 41:24-32. https://doi.org/10.1016/j.ejon.2019.05.001

23. HA Z, SM S, RM ES, WM S. Knowledge, attitudes and practices of safe handling of cytotoxic drugs among oncology nurses in tanta university hospitals. Egypt. J. Occup. Med . 2019 January 1;43(1):75-92. DOI: 10.21608/EJOM.2019.25119

24. Hosen MS, Hasan M, Saiful Islam M, Raseduzzaman MM, Tanvirul Islam M, Tazbiul Islam M. Evaluation of knowledge and practice of handling chemotherapy agents by nurses: a multi-centre studies in Bangladesh. Int J Community Med Public Heal. 2019 Oct; 6:4175-80. DOI: http://dx.doi.org/10.18203/2394-6040.ijcmph20194471

25. Abu Sharour L, Subih M, Bani Salameh A, Mala K M. Predictors of Chemotherapy Safe-Handling Precautions and Knowledge Among a Sample of Jordanian Oncology Nurses: A Model-Building Approach. Workplace Health Saf. 2021 Mar;69(3):115-23. https://doi.org/10.1177/2165079920959991

26.Al-Azzam SI, Awawdeh BT, Alzoubi KH, Khader YS, Alkafajei AM. Compliance with safe handling guidelines of antineoplastic drugs in Jordanian hospitals. J. Oncol. Pharm. Pract. 2015 Feb;21(1):3-9. https://doi.org/10.1177/1078155213517128

27. Chen HC, Lu ZY, Lee SH. Nurses' experiences in safe handling of chemotherapeutic agents: The Taiwan case. Cancer Nurs. 2016 September 1;39(5):E29-38. doi: 10.1097/NCC.0000000000000314

28. Kim O, Lee H, Jung H, Jang HJ, Pang Y, Cheong H. Korean nurses' adherence to safety guidelines for chemotherapy administration. Eur J Oncol Nurs. 2019 June 1; 40:98-103. https://doi.org/10.1016/j.ejon.2019.04.002

29. Jung J, Park JY. Factors influencing compliance with safety guidelines of anticancer drugs among nurses in general hospitals. Asian Oncol. Nurs. 2019 June 1;19(2):106-13. DOI: https://doi.org/10.5388/aon.2019.19.2.106

30.Connor TH, Zock MD, Snow AH. Surface wipe sampling for antineoplastic (Chemotherapy) and other hazardous drug residue in healthcare settings: methodology and recommendations. J Occup Environ Hyg. 2016 Sep 1;13(9):658-67. https://doi.org/10.1080/15459624.2016.1165912

31. Simon N, Vasseur M, Pinturaud M, et al. Effectiveness of a closed-system transfer device in reducing surface contamination in a new antineoplastic drug-compounding unit: a prospective, controlled, parallel study. PLoS One.2016 Jul 8;11(7): e0159052.

32. Randolph SA. Hazardous drugs: handling in health care settings. Workplace Health Saf. 2018 May;66(5):264-.264

33. Power LA, Coyne JW. ASHP guidelines on handling hazardous drugs. Am J Health Syst Pharm 2018 December 15;75(24): 1996-2031.DOI 10.2146/ajhp180564

34. Otero MJ, Vera R, González-Pérez C, Ayala de la Peña F, Peñuelas A, Quer N. Recommendations by the Spanish Society of Hospital Pharmacy, the Spanish Society of Oncology Nursing and the Spanish Society of Medical Oncology for the safe management of antineoplastic medication in cancer patients. Farm Hosp. 2018 Nov 1;42(6): 261-8.DOI: 10.7399/fh.11132

35. Alnaim L, Althiban A, Alrohaimi M. Practice Patterns for Oral Chemotherapy at Different Cancer Centers in Riyadh, Saudi Arabia: A Multicenter Observational Study. Indian J. Pharm. Sci. 2020 January 31;81(6): 1131-6.DOI: 10.36468/pharmaceutical-sciences.613

36. Huff C. Oral Chemotherapy: A home safety educational framework for healthcare providers, patients, and caregivers. Clin. J. Oncol. 2020 Feb 1;24(1).

37. May P, LaPlant K, McGee A. Practice model: Establishing and running an oral chemotherapy management clinic. Asia-Pac. J. Oncol. Nurs. 2017 Oct 1;4(4):299-303.
https://doi.org/10.4103/apjon.apjon_9_17

38. Nabhani-Gebara S. ISOPP Standards for the safe handling of cytotoxics. J. Oncol. Pharm. Pract. 2022 April 1;28(3_suppl): S1-26. https://doi.org/10.1177/10781552211070933

39.Carrington C, Stone L, Koczwara B, et al. The Clinical Oncological Society of Australia (COSA) guidelines for the safe prescribing, dispensing, and administration of cancer chemotherapy. Asia-Pac. J. Oncol. Nurs. 2010 Sep;6(3):220-37. https://doi.org/10.1111/j.1743-7563.2010.01321.x

40. Neuss MN, Popovich M, McNiff K, et al. 2013 updated American Society of Clinical Oncology/Oncology Nursing Society chemotherapy administration safety standards, including standards for the safe administration and management of oral Chemotherapy. J. Oncol. Pract. 2013 Mar;9(2S):5s-13s..DOI: 10.1200/JOP.2013.000874

41.Mekdad SS, AlSayed AD. Towards safety of oral anticancer agents, the need to educate our pharmacists. Saudi Pharm J. 2017 January 1;25(1):136-40.
https://doi.org/10.1016/j.jsps.2015.06.007

42. Goodin S, Griffith N, Chen B, et al. Safe handling of oral chemotherapeutic agents in clinical practice: recommendations from an international pharmacy panel. J. Oncol. Pract. 2011 Jan;7(1): 7-12. DOI: 10.1200/JOP.2010.000068

43. Chan A, Leow YC, Sim MH. Patients' perspectives and safe handling of oral anticancer drugs at an Asian cancer center. J. Oncol. Pharm. Pract. 2009 Sep;15(3): 161-5.doi: 10.1177/1078155208100584.