8-1-2022

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Recommended Citation

Yang S, Patel P, Corcoran A, et al. Gaps in patient education on safe handling and disposal of oral chemotherapy drugs: A pilot prospective cohort survey study. *J Contemp Pharm Prac*. 2022;70(2):23–33. https://doi.org/10.37901/jcphp21-00009

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Gaps in Patient Education on Safe Handling and Disposal of Oral Chemotherapy Drugs: A Pilot Prospective Cohort Survey Study

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Abstract

Background

Oral anticancer chemotherapy (OC) has been misperceived as being safer than intravenous chemotherapy, leading to its increased risk of improper handling and disposal. This survey study assessed the knowledge, practices and attitudes of pharmacists and patients regarding OC handling and disposal, gaps in knowledge and barriers to patient education.

Methods

Surveys were developed based on literature review and pilot study validation results. Patients completed a 33-item paper or electronic survey whereas pharmacists completed a 38-item electronic survey. Descriptive statistics and Fisher's exact test computed using the R Project were used for analyses.

Results

Pharmacist group (16/25, 62.5%) and patient group (14/29, 48.3%) believed that the oral route is safer than IV. Average overall correct response rates for pharmacist and patient groups were 78.3% and 61.9%, respectively. Significant gaps in knowledge between groups were observed in three sections ($p < 0.05$). Common barriers to providing patient education were insufficient training (70.8%) and insufficient time (50%).

Conclusion

Pharmacist and patient knowledge, awareness and practices of OC safe handling and disposal are suboptimal. Areas of knowledge gaps and barriers to patient education were identified. Enhanced supports are needed to empower pharmacists to assume an active role in patient education on safe handling and disposal of OC.

Introduction

The use of oral anticancer chemotherapy (OC) drugs has increased significantly since its introduction in the 1940s. Approximately 25% of 400 novel chemotherapy agents in development are oral agents that frequently require multiple daily dosing regimens.[1] With the burgeoning development of novel OC, the number of newly approved OC drugs is expected to increase multifold in the next few years. As reported in the literature, the advantages of oral over parenteral chemotherapy regimens can have a positive impact on the quality of life for patients by avoiding venipuncture and other adverse events associated with intravenous (IV) administration. It can provide a greater sense of control over their cancer therapies and shift drug administration from a traditional health care setting to a more comfortable, self-managed setting, such as in patients' homes.[1,2] However, alongside these benefits, OC drugs carry the same biohazardous properties that are associated with carcinogenicity, reproductive toxicity, genotoxicity and organ toxicity upon exposures.[3] Improper handling and disposal of these OC drugs not only increases the exposure risks in the immediate home space, but also to the environment and general population through air, surfaces, clothing, medical equipment and patient excrements.[4] A study by Fent et al. showed that tablet trituration can cause fine dust formation and local environmental contamination.[5]

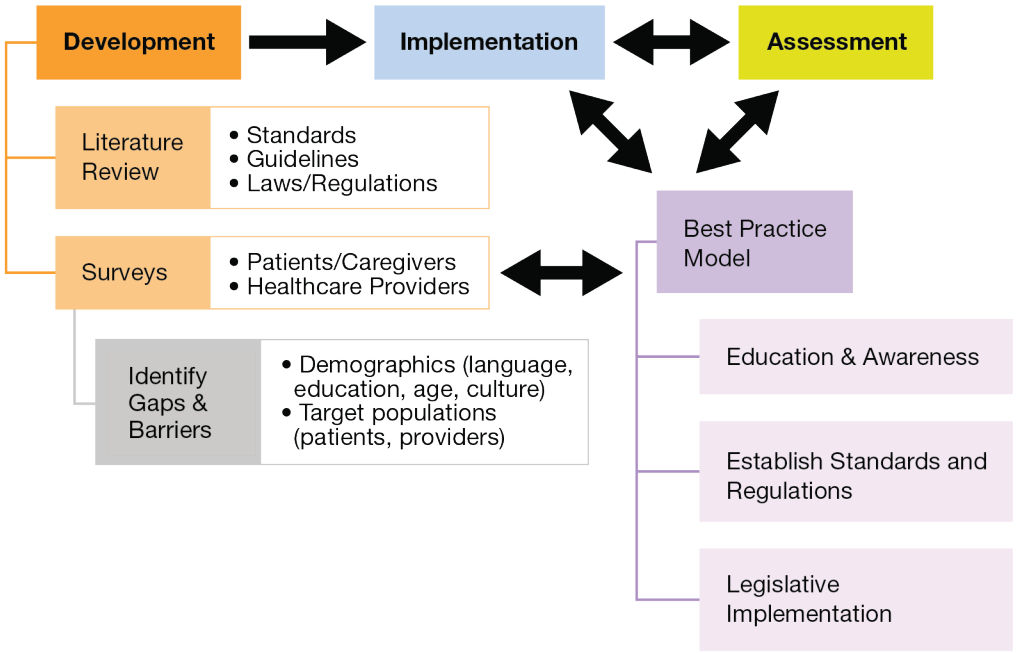
Several studies have shown that patients, caregivers and pharmacists generally misperceived OC to be less toxic than their IV counterparts.[6–10] In a survey that assessed community pharmacists' knowledge and attitudes toward oral chemotherapy, 94.7% of pharmacist respondents indicated that their pharmacy did not have separate counting trays devoted to dispensing cytotoxic drugs.[11] An earlier joint survey conducted by the Hematology Oncology Pharmacy Association (HOPA) and the International Society of Pharmacy Practitioners (ISOPP) demonstrated that only 67.6% of member respondents considered that the handling of OC drugs should require the same safety concerns as parenteral formulations.[12] A recent study also showed that 86% of the Veterans Affairs oncology patients perceived OC drugs as being safe to handle without wearing gloves.[10] Although the study was limited in the diversity of the study population, the results are concerning.

These documented misperceptions involving both pharmacists and patients can reasonably translate to less guarded handling and disposal of OC drugs at home, thereby increasing the risk of exposure to caregivers, visitors and the public through personal contact and environmental contaminations. The contamination of drinking water with pharmaceuticals or medications has been reported in environmental studies.[13–15] An earlier study showed that more than half of patients flushed unused or expired medication into the toilet, and only 22.9% reported returning medication to a pharmacy for disposal.[16] Another report found 38% of the patient respondents disposed of medications in the toilet, sink or the trash.[17] Based on the improper practices of pharmacists and patients reported when handling OC drugs and disposing of other medications,[10,11,14,15] the

potential environmental consequences from OC both in the short and long term cannot be ignored. Although a few published guidelines have addressed the safe handling and disposal of OC drugs, they remain focused upon institutional practice and are rarely adapted for the home setting.[8,18] A best practice model emphasizing outpatient care is needed to improve awareness, education and safe practice around OC handling and disposal by patients and caregivers.

The purpose of this study is to understand the current knowledge, awareness, practices and attitudes of pharmacists and patients on the handling and disposal of OC drugs. By identifying potential gaps in knowledge among pharmacists and patients and practice barriers of pharmacists to provide patient education on this topic, we hope to optimize educational efforts and to develop a regional best practice model for safe handling and disposal of OC drugs (Figure 1).

Figure 1. Schematic of the Quality Improvement Process for the Proposed Best Practice Model



Methods

We conducted a questionnaire-based survey study, approved by the Chapman University Institutional Review Board (IRB), to evaluate the knowledge, awareness and practice of safe handling and disposal of OC drugs among pharmacists and patients. Two separate pharmacist- and patient-surveys were developed based on literature, guidelines and professional standards.[1,8,12,19] Both surveys contained demographic items and identical content items to assess participants' knowledge, awareness and attitudes on OC handling and disposal. The pharmacist survey included supplemental items catered toward practice on patient education. The identical content items were analyzed for differences to determine the gaps in knowledge between the pharmacists and patients. The pharmacist survey was first pilot tested with 15 health care providers, including nurses, oncologists and pharmacists. The patient pilot survey was conducted with 11 patients at a private oncology practice office located in Southern California. The results of both pilot studies demonstrated that the surveys were comprehensible, relevant and able to be completed within a reasonable period of time. The surveys with mild revisions were subsequently used in the current studies. The pilot patient data were also included in the final data analysis as the survey revisions did not alter the evaluability of the responses.

The surveys (Appendixes 1 and 2) consisted of qualitative (focused on demographics, practice and attitudes) and quantitative (focused on knowledge and practice) items. There were 23 and 24 quantitative items in the pharmacist and patient surveys, respectively. These items were categorized into six sections; the number of items in each section were: handling of OC (N = 4), OC storage in the home (N = 3), physical manipulation of OC (N = 1 in pharmacist survey; N = 2 in patient survey), handling of waste and clothing (N = 8), disposal of OC (N = 3) and safety and exposure risk of OC (N = 4). Selected content items (N = 11) were deemed as "critical items," in which 100% competency is desired based on their significance in safe practice. Fifteen qualitative items were included in the pharmacist survey to collect demographic information (N = 4), patient education practice (N = 5), OC dispensing practice (N = 5) and attitude toward OC safe disposal (N = 1). Three of these qualitative items with open-ended responses were used to identify pharmacists' roles and the potential barriers in delivery of patient education on OC handling and disposal, such as insufficient training and insufficient time. The patient survey included seven demographic and two medication history items.

Pharmacist Survey Study

The 38-item pharmacist survey was conducted in collaboration with the California Society of Health-System Pharmacists (CSHP). The Qualtrics survey link was distributed by email via CSHP to its pharmacist members across the state of California. Participants must have met the following inclusion criteria: at least 18 years old, a registered

pharmacist licensed in California and actively practicing in an area where dispensing or handling oral chemotherapy medications occurs.

Eligible participants reviewed a study information page (Appendix 3) upon entering the survey site and provided electronic consent prior to completing the questionnaire. The participants had 60 days to complete the survey, and reminder emails were sent periodically throughout the timeframe to maximize the participation and response rates. "Force response" of each item and "no backward navigation" features in Qualtrics were used to set up the survey. Following the data collection, the IP addresses of the participants were stripped using the existing Qualtrics "anonymize response" feature. No identifiable information was collected or stored by CSHP nor the researchers.

Patient Survey Study

The IRB-approved 33-item patient statewide survey was conducted at a private practice oncology office in Southern California and a Walgreens pharmacy in Northern California. Subjects who received care at these sites and met the eligibility criteria were invited to participate in the study. The inclusion criteria include: at least 18 years old, currently self-administering OC or completed the OC regimen within the last 12 months and must be able to complete the survey in English independently or with aid from a caregiver. All subjects signed an IRB-approved informed consent prior to enrollment. Subjects were given the option to complete the survey via hard copy or electronically in Qualtrics. Subjects who preferred to complete the survey via a hard copy were provided a survey package including a signed IRB-approved informed consent and a hard copy of the survey to complete during their visit. The completed surveys were collected on-site. Subjects who preferred an electronic survey were provided the electronic link by the investigator and a copy of the signed informed consent. The subjects then completed the survey either during their visits using an iPad provided by the site or at home.

Data Handling and Analyses

Both pharmacist and patient data were deidentified, exported and saved into secure encrypted folders that were accessible only by the research team for statistical analysis. Survey data were presented as numbers or percentages for categorical variables. Critical items refer to the contents where 100% patient/caregiver and pharmacist competencies are desired were coded as "Yes" or "No." Potential gaps of knowledge were identified by examining the correct responses to the survey items among and between study groups. If a statistical significance of varied difference in the knowledge base was observed between the two study groups, this indicated a possible gap and/or barrier that may be preventing the pharmacists from translating their knowledge to patients through counseling and education.

All statistics were performed using The R Project software for statistical computing version 3.6.2.[20] Collaborative descriptive analyses were used to assess the demographic data collected from the two groups. To compare the responses collected from the pharmacists and patients, a Fisher's exact test was computed using the R package "epitools."[21] Relative risk ratio of pharmacists to patients and the 95% confidence intervals were used to show the magnitude of the differences between the two groups. Due to the use of multiple statistical analyses, an adjustment to the p-values was added using the method described by Benjamini and Hochberg.[22] Two-sided adjusted p-values of < 0.05 were considered significant.

Results

The surveys for pharmacists and patients were conducted from September 2016 to September 2019 following IRB approval. All study participants completed the survey online or used a paper copy.

Subject Characteristics

Characteristics of study participants are summarized in Table 1. Pharmacist participants (N = 25) were predominately females (68%). Experience varied among different areas of practice with a majority (60%) practicing for 10 or more years, and only 3 out of 25 participants chose less than two years. The majority of the pharmacists (68%) practiced in hospital inpatient settings, followed by oncology specialty (2/25, 8%) and ambulatory care (2/25, 8%). Only one participant worked in the community pharmacy setting (4%). Furthermore, over half of the pharmacist participants (52%) indicated they were not specialty trained in oncology.

Patient participants (N = 29) were 62% female with the majority aged 50 to 64 years old. More than half of the patients had a college or higher education (N = 22, 76%). The most common ethnic group was Caucasian (55%), followed by Asian/Asian American (24%) and Latino/Hispanic or African American (6.9%). Of note, 45% of patient participants reported vision impairments and 14% reported hearing problems. The majority of the patient participants had previously received OC (72.4%) with 52.4% having received four or more OC regimens.

Survey Results

Pharmacist survey: 24 out of 25 pharmacists (96%) completed all the survey items (Table 1) and their correct response rates to each item are outlined in Table 2. As shown in Figure 2, the overall correct response rates of "handling of waste and clothing" and "disposal of OC" were the lowest among all the survey sections (70.8% and 72.2% respectively). "Handling of waste and clothing" was the largest section containing eight items; the most commonly missed items were: "Patient double flushes toilet 48 hours after last chemotherapy" (D5, 37.5% correct) and "Caregiver must double flush after disposing of patient's body waste" (D7, 45.8% correct). Both items were critical items where a 100% correct response was desired.

Other critical items with suboptimal responses revealed in the pharmacist survey included washing hands (A2, A4), crushing or splitting tablets (C1, C2), storage in original container (B1, B2), wearing gloves when handling waste (D1), disposing of unused OC in regular trash (E1) and skin exposure of OC (F2). More than half of the pharmacists thought of oral anticancer chemotherapy as safer compared to IV chemotherapy (F4, N = 15, 62.5%).

For the items inquiring frequency in providing patient education on handling oral chemotherapy drugs, 44% of the pharmacists in the survey indicated an "as needed" basis (11/25), 24% responded "at initiation of OC therapy" (6/25), and 16% responded "never" (4/24). Only two participants

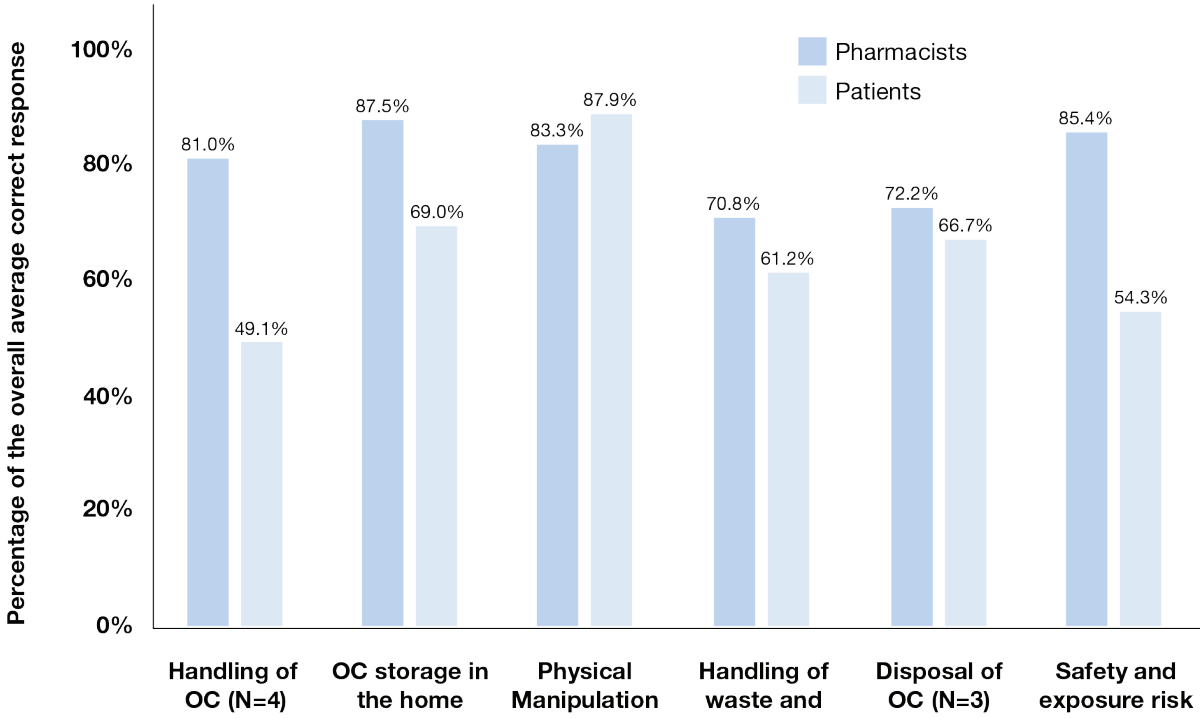
Table 1. Pharmacist and Patient Characteristics

Pharmacist demographics and patient education practice			Patient demographics and medication history		
Characteristics (N = 25)	**Groups**	**Number (%)**	**Characteristics (N = 29)**	**Groups**	**Number (%)**
Gender (N = 25)	Female	17 (68%)	**Gender (N = 29)**	Female	18 (62.1%)
	Male	8 (32%)		Male	11 (37.9%)
Years of practice (N = 25)	0 to 2	3 (12%)	**Age (N = 29)**	18 to 34	3 (10.3%)
	2 to 5	3 (12%)		35 to 49	3 (10.3%)
	5 to 10	4 (16%)		50 to 64	14 (48.3%)
	10 to 25	8 (32%)		65 to 79	5 (17.2%)
	25 or more	7 (28%)		80 and above	4 (13.8%)
Area of practice (N = 25)	Ambulatory care	2 (8%)	**Education (N = 29)**	High school	7 (24.2%)
	Community pharmacy	1 (4%)		College	13 (44.8%)
	Hospital inpatient pharmacy	17 (68%)		Graduate school	9 (31%)
	Hospital outpatient pharmacy	1 (4%)			
	Oncology specialty practice	2 (8%)			
	Other	2 (8%)			
Oncology trained (N = 25)	Yes	12 (48%)	**Self-reported impairment (N = 29)**	Vision	13 (44.8%)
	No	13 (52%)		Hearing	4 (13.8%)
Frequency of patient education on handling (N = 25)	As needed	11 (44%)	**Ethnic background (N = 29)**	White/Caucasian	16 (55.2%)
	Every appointment	2 (8%)		Asian/Asian American	7 (24.1%)
	Initial education only	6 (24%)		Latino/Hispanic/Spanish	2 (6.9%)
	Never	4 (16%)		Black/African American	2 (6.9%)
	Other	2 (8%)		Prefer not to disclose	2 (6.9%)
Frequency of patient education on disposal (N = 25)	As needed	9 (36%)	**Patient demographic distribution (N = 29)**	Northern California	18 (62.1%)
	Every appointment	2 (8%)		Southern California	11 (37.9%)
	Initial education only	6 (24%)			
	Never	7 (28%)	**Patients on OC (N = 29)**	Previously on OC	21 (72.4%)
	Other	1 (4%)		Currently on OC	8 (27.6%)
Major barrier to proper education (Select all that apply) (N = 24)	Insufficient time	12 (50%)	**Number of prior OC regimens/drugs (N = 21)**	One	6 (28.6%)
	Insufficient training	17 (70.8%)		Two	3 (14.3%)
	Never heard about it	1 (4.2%)		Three	1 (4.8%)
	Not my role/ responsibility	2 (8.3%)		Four or more	11 (52.4%)
	Other	2 (8.3%)			
Completed surveys (N = 25)	Yes	24 (96%)	**Completed surveys (N = 29)**	Yes	25 (86.2%)
	No	1 (4%)		No	4 (13.8%)

Table 2. Survey responses of pharmacists (RPh) and patients (Pt) summarized by different sections.

	RPH correct response	PT correct response	Relative risk ratio of correct response (RPH/PT)	95% conf. interval	P value	Adjusted P value
A. Handling of OC						
A1. Patient wear gloves	10/25 (40.0%)	4/29 (13.8%)	2.1875	(0.9235, 5.1814)	0.03498	0.09329
A2. Patient wash hands*	24/25 (96.0%)	16/29 (55.2%)	2.3214	(1.5462, 3.4854)	0.000595	0.004756
A3. Caregivers wear gloves	23/25 (92.0%)	14/29 (48.3%)	2.3319	(1.4899, 3.6499)	0.000905	0.005432
A4. Caregiver washes hands*	24/25 (96.0%)	23/29 (79.3%)	1.7516	(1.1504, 2.6669)	0.1076	0.2582
B. Storage of OC						
B1. Keep OC in original container	21/24 (87.5%)	22/29 (75.9%)	1.3682	(0.8299, 2.2555)	0.3183	0.5877
B2. Do not place OC in pillbox with other meds.	19/24 (79.2%)	18/29 (62.1%)	1.4132	(0.8853, 2.2559)	0.2348	0.5122
B3. OC can be placed near food or drinks	23/24 (95.8%)	20/29 (69.0%)	1.9350	(1.3215, 2.8333)	0.01539	0.0528
C. Physical manipulation of OC						
C1. Crush tablet*	20/24 (83.3%)	27/29 (93.1%)	0.5802	(0.1823, 1.8473)	0.3923	0.6517
C2. Split or cut tablet*	20/24 (83.3%)	24/29 (82.8%)	1.0185	(0.5351, 1.9386)	1	1
D. Handling of waste and clothing						
D1. Wear gloves when handling urine and body waste*	22/24 (91.7%)	24/29 (82.8%)	1.3690	(0.7945, 2.3590)	0.4362	0.6544
D2. Wear gloves when handling sheets or clothing	22/24 (91.7%)	11/29 (37.9%)	2.7000	(1.6309, 4.4700)	0.0000561	0.000135
D3. Wash hands after handling urine and body waste*	24/24 (100%)	28/29 (96.6%)	1.8571	(1.4440, 2.3885)	1	1
D4. Wash hands when handling sheets or clothing	24/24 (100%)	22/29 (75.9%)	2.0909	(1.5462, 2.8276)	0.01237	0.04948
D5. Patient double flush toilet 48 hours after last chemotherapy*	9/24 (37.5%)	13/29 (44.8%)	0.8734	(0.5368, 1.4213)	0.7799	0.9359
D6. Caregiver must flush toilet before using it if it is shared with the patient	11/24 (45.8%)	13/29 (44.8%)	1.0186	(0.6221, 1.6676)	1	1
D7. Caregiver must double flush after disposing patient's body waste*	11/24 (45.8%)	18/29 (62.1%)	0.7384	(0.4391, 1.2417)	0.2772	0.5544
D8. Patient's sheets and clothing must be washed separately	13/24 (54.2%)	13/29 (44.8%)	1.1852	(0.7221, 1.9454)	0.5857	0.7809
E. Disposal of OC						
E1. Unused OC be disposed in tightly closed container in regular trash*	22/24 (91.7%)	25/29 (86.2%)	1.2533	(0.6701. 2.3442)	0.6779	0.8562
E2. Dispose of unused OC in the toilet and flushed	21/24 (87.5%)	23/29 (79.3%)	1.2754	(0.7422, 2.1916)	0.4875	0.6882
E3. Empty OC containers can be discarded in regular trash	9/24 (37.5%)	10/29 (34.5%)	1.0618	(0.6308, 1.7872)	1	1
F. Safety of OC						
F1. Individual can be exposed at home by inhalation	21/24 (87.5%)	17/29 (58.6%)	1.7882	(1.1579, 2.7617)	0.03135	0.09329
F2. Individual can be exposed by skin contact*	22/24 (91.7%)	17/29 (58.6%)	1.9664	(1.2970, 2.9813)	0.01095	0.04948
F3. Individuals can be exposed by unintentional digestion*	24/24 (100%)	15/29 (51.7%)	2.6000	(1.7481, 3.8671)	0.000063	0.000758
F4. Oral anti-cancer chemotherapy is safer than IV chemotherapy	15/24 (62.5%)	14/29 (48.3%)	1.2946	(0.7949, 2.1087)	0.4073	0.6517
***Critical items (N = 11) - items in which 100% patient and pharmacist competency are desired.**						

Figure 2. The overall correct response rates of pharmacists and patients in six assessed sections. *N* represents the number of items in each section. The bars represent the overall average correct response rate (%) of each section, calculated by [total correct responses/total responses received x 100%].



(8%) performed patient education during every appointment. A similar pattern was observed in terms of the frequency of performing patient education on OC disposal, with 36% "as needed" and 24% on initial education only. More pharmacists chose "never" in terms of educating patients on disposal (N = 7) compared to handling (N = 4).

When asked to identify barriers to patient education on OC, the most frequently selected response by pharmacists was insufficient training (70.8%) followed by insufficient time (50%). Few pharmacists (8.3%) felt that it was not their role/responsibility to provide patient education on OC. Two participants chose "other" but did not provide a more detailed explanation. One pharmacist chose "never heard about this."

Patient survey: 25 out of the 29 (86%) patients completed all the survey items. The patient group correct response rates across all six sections ranged from 49.1% to 87.9%, with a cumulative overall correct response rate of 61.9% (Table 2,). The lowest correct rate was in "handling of OC" (49.1%), followed by the "safety and exposure risk of OC" section (54.3%). The patient group achieved the highest correct rate in the "physical manipulation of OC" section (87.9%).

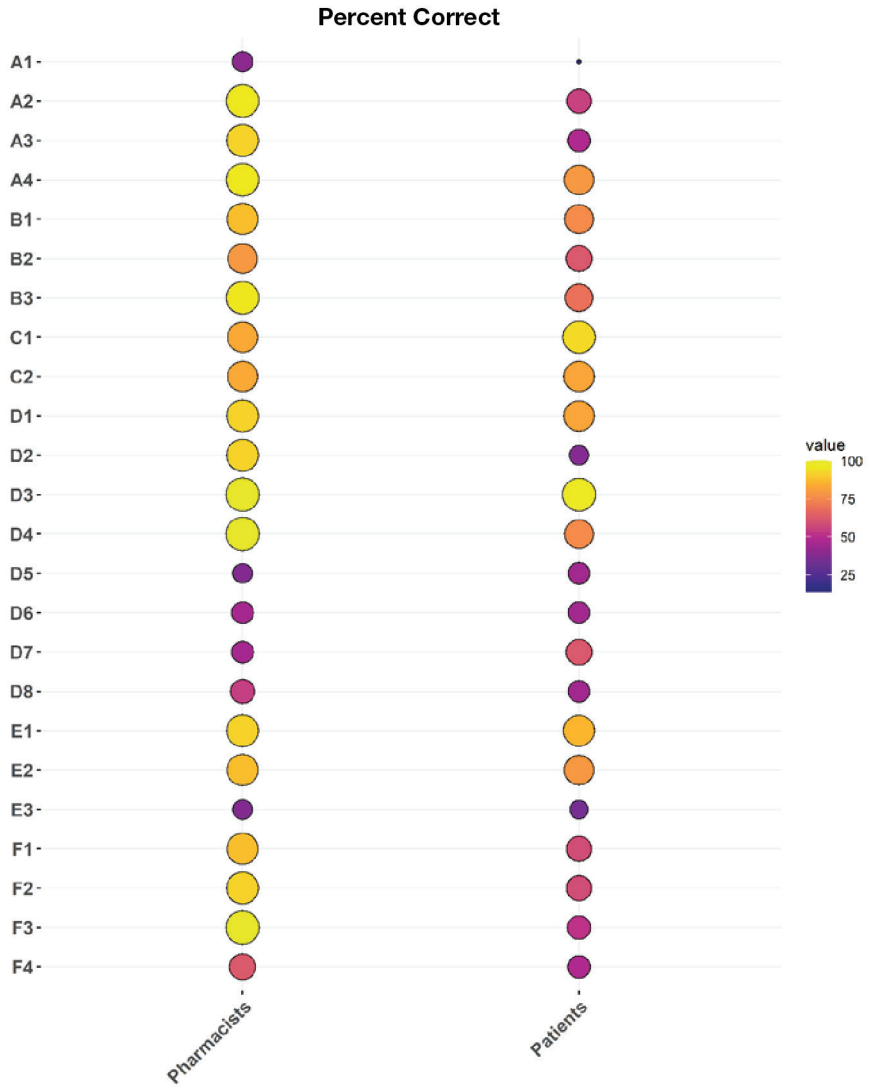
As noted in Table 2, the patient group did not achieve a 100% correct response rate in any of the critical items. Correct response rates below 80% were observed in six out of the 14 critical items, including: proper hand-washing habits for patients (A2, 55.2%) and caregivers (A4, 79.3%); bathroom cross-contamination avoidance practice for patients (D5, 44.8%) and caregivers (D7, 62.1%); and exposure risks via dermatologic route (F2, 58.6%) or unintentional ingestion (F3, 51.7%). In addition, almost half of the patient participants believed that "oral anticancer chemotherapy is safer than IV chemotherapy" (F4, 48.3%).

Comparative Data Between the Two Study Groups

Figure 2 illustrates the overall correct response rates in each of the six sections of the quantitative items for each study group. The pharmacist group consistently scored better than the patient group in five of the six sections. Although the patient group scored marginally higher than the pharmacist group in the "physical manipulation of OC" section, both groups scored over 80%.

We further analyzed the responses of each item between pharmacists and patients as summarized in Table 2. Risk ratios with 95% confidence intervals were computed to show the magnitude of the differences along with a Fisher's exact test to determine statistical significance. There were six items where pharmacists' correct response rates were significantly higher compared to patients. These items were distributed in three sections: handling of OC, handling of waste and clothing and safety and exposure risk of OC. Pharmacists achieved 100% correct response rates in two items ("wash hands when handling sheets or clothing" and "individuals can be exposed by unintentional digestion") compared to 75.9% ($p = 0.04948$) and 51.7% ($p = 0.000758$) in patients, respectively. In terms of patients washing their hands (A2), 96% pharmacists chose "Yes" and only 55.1% of patients think it is necessary ($p = 0.0047$). Other significant disparities observed between pharmacists and patients include "caregivers wearing gloves" (A3, $p = 0.0005$), "wearing

Figure 3. Comparison of the survey responses between pharmacist and patient groups visualized using a balloon plot. The value of the correct scores were represented by circle color and size. A bigger size with lighter color shows a higher correct percentage (%).



gloves when handling sheets or clothing" (D2, p = 0.0001) and "exposure risk of OC by skin contact" (F2, p = 0.049).

Similar notable insufficiencies of knowledge on OC identified in both pharmacist and patient participants were in the areas of "handling of waste and clothing" (D5-D8), "disposal of empty containers in regular trash" (E3) and "patients wearing gloves" (A1) as illustrated in Figure 3.

Discussion

With the increased use of OC, safe handling and disposal of hazardous drugs need to be established and applied. In examining the existing guidelines and regulations for health care providers in proper handling and administration of anticancer chemotherapy across the health care continuum in the U.S. and internationally, it is apparent that there is limited information available specifically on the safe handling and disposal of OC. In 2013, ASCO and the Oncology Nursing Society (ONS) published their joint updated standards for the safe administration and management of oral chemotherapy.[19]

An international pharmacy panel also recommended safe handling of oral chemotherapeutic agents in clinical practices.[8] Despite additional guidelines that had the intention to address the area of oral chemotherapy,[3,8,18,19,23–25] few of them provided comprehensive information and guidance for safe handling and disposal of hazardous medications in home settings where OC is primarily being administered. In recent years, increasing numbers of professional organizations, health care networks and hospitals have developed provider resources and/or patient education materials on OC.[18,23,26,27] However, due to the scope of their membership and target audience, these efforts may only benefit a small number of users.

Pharmacists are regarded as the medication experts for patient education and counseling due to their comprehensive education in pharmacology.[28] In our pilot survey, pharmacists were highly regarded by other health care providers to play an active role in patient education on proper handling and disposal of OC. It has been well documented that pharmacist interventions can improve outcome measurements in

outpatients with cancer aged > 50 years, leading to significantly decreased adverse events and symptoms related to cancer and improvements in patient satisfaction and quality of life.[29] Additional studies also reported a significant improvement in knowledge-attitude-practice for chemotherapy[30] and improved awareness and knowledge regarding adherence to laboratory parameter monitoring following pharmacist interventions.[31] Pharmacists play a vital role in medication counseling and education, and should be knowledgeable in order to keep patients and caregivers well informed and to empower patients to make their own health decisions concerning the safety of OC. Although the surveyed pharmacists scored higher than patients in five out of six sections of the quantitative items and achieved 100% correct rate in two critical items, the overall responses from pharmacists were suboptimal. The average correct response rate in the quantitative items summarized in Table 2 was 78.3% (median = 87.5%, range = 37.5%-100%) with about one-third of the items below 80% (7/24).

The need to improve patient knowledge and awareness is also echoed by the results of the surveyed patients. The average correct response rate in the quantitative items was only 61.9% (median = 60.3%, range = 13.8%-96.6%). The notable deficiencies of awareness on the safety and exposure risk of OC at home provide the rationale for addressing this knowledge gap. Optimizing the pharmacist counseling and patient education may improve patient awareness of OC safety.

The suboptimal performances of both study groups substantiated the need for more education for pharmacists and patients. The data from our study highlighted the specific areas that deserve more attention in the design of the educational model. A major concern identified by our survey is that more than half of the pharmacist participants (F4, 62.5%) and almost half of the patients (48.3%) believe oral anticancer chemotherapy is safer than intravenous chemotherapy. This misconception may have a negative impact on the pharmacists' attitudes, preventing them from actively engaging in patients' education and developing safe practice habits. This is evidenced by the low frequency of providing patient education from the pharmacist survey response. Continual education among pharmacists and other health care providers on these topics is greatly warranted to improve their awareness and attitude, which may eventually translate into the patients' safe practices at home through effective counseling. The patients and caregivers carry an equally important role in safe practices when self-managing their oral chemotherapy at home. Raising their knowledge and awareness can improve outpatient OC care and safe practice at home. Given the fast development in transitional care management, more inpatient pharmacists are performing structured discharge medication communication and facilitation and timely post discharge follow-up. With the increased prescribing of oral chemotherapy drugs and their hazardous properties, it is imperative that pharmacists in all practice settings must be prepared to provide clear and concise patient education including safe handling and disposal information. Motivational interviewing and teach-back methods can be used to improve the medication compliance and confirm the patient comprehension.

In examining the disparities of the response rates when comparing the two study groups as seen in Figure 2, we identified the knowledge gaps between the pharmacists and the patients. The sections that showed a high level of disparity with the pharmacist group scoring above 80% are more likely due to "insufficient time," whereas the sections where both groups did not score well may indicate "insufficient training." Recognizing that oncology training in pharmacy education typically occurs post-graduation primarily for those who enter specialty practice, a national comprehensive guideline statement would be greatly beneficial in standardizing the education and practice in the safe handling and disposal of OC in the self-managed setting. Our data from the surveys provided insight into the design of the educational program, guideline development and resource support.

Aside from insufficient training and resource support, another major barrier identified from our study was insufficient patient counseling time, which is consistent with an earlier study conducted in community pharmacies.[32] Predeveloped patient education information sheets on OC may allow pharmacists to conduct patient education more effectively with the time restriction and for patients to possess written information as a reference when needed. In recent years, more online informational resources have been developed and available for reference and patient education, such as the OralChemoEdSheets.com.[27,33]

Lastly, unsafe practice in the home setting can lead to environmental exposure. In the last two decades, water treatment centers had reported contamination of groundwater and drinking water by medications.[34–36] Although these publications did not specifically examine hazardous agents, it is logical to expect the mechanisms of environmental contamination to be similar irrespective of the type of medications. Since 2012, an increasing number of California counties have successfully passed and implemented ordinances on safe medication disposal.[37–41] These ordinances mandate the collection and safe disposal of unneeded medications including hazardous agents to prevent pollution of the environment. However, as shown in an earlier study,[9] patients rarely received instructions from the dispensing pharmacy on the proper disposal of hazardous drugs and their containers, and the medication containers were not labelled accordingly. The California Board of Pharmacy recognizes the impact of safe handling and disposal of OC to the public health.[42,43] On Jan. 30, 2019, the board issued a policy statement to encourage voluntary inclusion of a standardized hazardous drug symbol in the OC prescription labels when appropriate, which serves as a reminder for pharmacists to provide patient education and for patients and caregivers to be mindful of special handling and disposal of these medications.[44]

A major limitation of this study is the relatively small subject size in both study groups. The number of expected pharmacist participants was targeted at 500 based on a 20% response rate of the estimated eligible members of CSHP. However, the number of participants who completed the online survey was low despite reminder efforts. Although our study achieved statistically significant differences in the analyses, a nationwide, large-scale study is warranted to capture more diverse and larger subject populations. Furthermore, in this study, we were not able to recruit caregivers, who play an important role in providing cancer patient care at home and can provide valuable insights for our research objectives. In addition, the pharmacist participants were not well distributed

with a majority from inpatient-based practices, which may be attributed to the membership distribution of CSHP. Despite this limitation, most of the outcome data observed from our survey were consistent with the findings from an earlier study conducted among community/retail pharmacists.[11] Lastly, both surveys used for this study did not go through the full validation process and the internal consistencies have not been evaluated.

Conclusion

Our survey data demonstrated that the knowledge, awareness and practices of safe handling and disposal of OC are suboptimal for both pharmacist and patient groups. Education for both study populations is needed to enhance the knowledge and safe practices of OC. Pharmacists should establish active roles in patient education and counseling on safe handling and disposal of OC. Comparing the responses between pharmacists and the patients, significant gaps in knowledge were observed in areas of OC handling, handling of body waste and clothing and the exposure risk of OC. Enhanced trainings and resources are needed to empower pharmacists to assume an active role in patient education and counseling on safe handling and disposal of OC.

Informed Consent and Patient Details

I confirm all patient/personal identifiers have been removed or disguised so the patient/person(s) described are not identifiable and cannot be identified through the details of the study.

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Conflict of Interest

The authors report no conflicts of interest.

Author Contribution

Sun Yang and Siu-Fun Wong: Conceptualization, funding acquisition, investigation, project administration, methodology and writing–original draft, review and editing.

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Katherine Gruenberg: Funding acquisition, methodology, data curation, formal analysis, investigation and writing–original draft, review and editing.

Neda Noori Nassr: Data curation, formal analysis, methodology, investigation and writing–original al draft, review and editing.

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Funding

This work was supported by the National Institutes of Health/National Cancer Institute [1K08CA179084, Sun Yang]; and Chapman University School of Pharmacy [Sun Yang].

Acknowledgments

The authors thank: CUSP PharmD Class of 2018 Michael Phan, Esther Shin and Thien Huynh for their contributions in creating the groundwork of this study; the Hematology Oncology Group of Orange County in supporting for the patient recruitment in Southern California; Walgreens Store # 15331 for supporting patient recruitment in Northern California; and the California Society of Health-System Pharmacists for their collaborations and support in pharmacist recruitment in California. The authors also want to thank Dean Jordan and the Dean's Office for supporting the PharmD students in the conduction of this study.

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