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# The role of the pharmacist in the multidisciplinary approach to the prevention and resolution of drug-related problems in cancer chemotherapy

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## Abstract

**Background:** Clinical pharmacists have important roles in implementing scientifically valid knowledge and advice on safe, reasonable use of pharmaceuticals. Clinical pharmacy services were introduced and evaluated in oncology clinic in a tertiary university hospital.

**Methods:** A prospective interventional study was conducted from November 2017 to March 2018. Drug-related problems were classified using the Pharmaceutical Care Network Europe drug-related problem classification tool v8.01. The main outcome measure is the proposed interventions aimed at identification of the drug-related problems, the role of the pharmacists in the resolution, and the rate of acceptance of these recommendations by physicians.

**Results:** A total of 102 patients were included in the study, who were treated with at least two cycles of any cancer type and stage. A total of 55 (53.9%) patients had 251 drug-related problems. Drug-related problems mainly involved antihypertensive (31.6%), antidiabetic (17.8%), and herbal agents (31.6%). Treatment effectiveness was the major type of drug-related problems (50.2%) followed by treatment safety (29.1%). A total of 211 (100%) interventions were accepted and regarded as clinically relevant. Prescriber informed only were the most common types of intervention at the prescriber level. Eighty-six point four percent identified drug-related problems were solved, 9.8% of the problems were partially solved, 2.3% problems were unsolved.

**Conclusion:** Clinical pharmacy services may have optimized therapy effectiveness, prevent adverse effects and unclear/compliant problems. The pharmacist interventions were highly acknowledged by oncologists and patients; this may indicate the presence of a great convenience and need to implement Clinical pharmacy services in alternative hospitals in Northern Cyprus.

## Keywords

Oncology pharmacy, chemotherapy, clinical pharmacy services, drug-related problems

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## Background

Cancer is the universal name for a large group of disease, defined as an uncontrolled proliferation of abnormal cells, and invasion of the body by spreading to nearby or distant organs or tissues. Other common names are malign tumors and neoplasms. Cancer can affect almost every part of the body and includes many anatomical and molecular subtypes, each of which requires specific treatment strategies. Cancer is the

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second leading cause of death globally and accounted for 8.8 million deaths in 2015.[1] In Cyprus population, 3400 people newly diagnosed with cancer and 1500 of them died from cancer in 2012.[2]

Chemotherapy is the main treatment for cancer and benefits patients in the form of decreased relapse and metastasis and longer overall survival.[1] However, chemotherapy is one of the most common treatment method associated with drug-related problems (DRPs), which are directly related to adverse drug reactions (ADRs)[2] and medication errors.[3,4]

A DRP is "an event or circumstance involving drug therapy that actually or potentially interferes with desired health outcomes".[5] There are strong evidence-based relationships between the negative consequences of DRPs and major health problems, and the mortality, morbidity, and costs associated with DRP are very high.[6]

Identification and resolution of drug-related problems associated with prescription errors are one of the main activities of the pharmaceutical care.[6] Pharmaceutical care is defined as "the pharmacist's contribution to the care of individuals in order to optimize medicines use and improve health outcomes".[7]

Clinical pharmacy services (CPS) help in reducing hospital mortality rates.[8] Clinical pharmacy is defined as the "area of pharmacy concerned with the science and practice of rational medication use".[9] CPS are essential components of the delivery of pharmaceutical care.[10] In many studies, the participation of pharmacists in the treatment of cancer patients with chemotherapeutics has been shown to improve the management of drug-related risk factors.[11] This care may occur in collaboration with physicians or nurses, and it consists of pharmacist interventions, which may improve the quality of safe preparation, proper administration, and relevant disposal of cancer therapies; and supply, cost, and reimbursement for cancer therapies is crucial in developing collaborative institutional guidelines and practice-based decisions.[12]

Many studies have been achieved in oncology clinics to detect and characterize DRPs.[13–16] For instance, a total of 952 DRPs were identified in 546 patients in the Deventer Hospital, The Netherlands. The most frequent causes of DRP were drug interactions (246 in 157 patients) and potential contraindications (201 in 143 patients).[17] However, in a very limited study, the benefits and impact of oncology pharmacists' interventions have been examined.[11,12]

Clinical pharmacy and oncology pharmacy services are being installed for the first time in hospitals in North Cyprus. We continue to work on standard application procedures with the aim of serving both international guidelines and local conditions. None of the hospitals in this region are currently employing a pharmacist at the oncology clinics. This service was launched for the first time at the Near East University Hospital. The present study CPSs were presented in oncology clinics and the impact of these services were examined. While this step presents a challenge for the clinical pharmacy profession, but it may provide a new path for clinical pharmacy as an indispensable aspect of pharmacy practice in this region. Oncology specialized clinical pharmacists can provide significant benefits for oncologists, chemotherapy nurse and for patients who have no contact with them until now.

## Objectives

This study aimed to implement CPS in the Near East University Hospital in the oncology clinic, to identify the prevalence and nature of the DRPs encountered with the relevant factors and to understand the benefits to the treatment of the oncology pharmacists in this process.

It is anticipated that the impact of this study on the oncology clinics will be as follows;

- The establishment of CPS in oncology clinics provides significant benefits for minimizing and/or eliminating drug-related problems.
- Clinical pharmacists can inform and be alerted to health-care professionals in oncology clinics about the types, causes, and solutions of the drug-related problems.
- As a result of the successful implementation of CPS, a significant reduction in drug-related problems will promote collaboration between physicians and clinical pharmacists and encourage multidisciplinary work.

## Methods

### *Study setting*

The study was performed in the oncology department on in- and outpatients from November 2017 to March 2018 at Near East University Hospital, which is the biggest and leading medical facility in Nicosia, Northern Cyprus. The clinic was served by two medical oncologists, one internal medicine doctor, and five chemotherapy nurses.

### *Study design*

This study was a prospective interventional study in which CPSs were provided for in and outpatients by independent clinical pharmacists and documented for four months in oncology clinic. There were no clinical pharmacists assigned to work before the study and there was no interaction with a clinical pharmacist prior to the study. All patients who came to the hospital

for daily chemotherapy application and/or stay in the oncology clinic for at least two cycles are recruited into the study. Patients who came out of our service with the reason that they continued treatment in another hospital or died were excluded.

In addition, the medical condition and treatment plan of each patient was interviewed and discussed face to face or telephone by physicians. Any changes in the course of treatment were recorded (e.g. patient vital findings, laboratory values, and treatment). Patient services were implemented along medication reconciliation/change in medication, monitoring drug therapy, clarify DRPs, and providing drug information.

Appropriate interventions for each identified DRP were interviewed and discussed with the prescriber directly. The most convenient solution for the encountered problems is proposed to the oncology clinic team. The clinical pharmacists' recommendations were evaluated, approved, and taken into consideration by physicians. The DRPs were categorized using Pharmaceutical Care Network Europe (PCNE) DRP classification tool v8.01, which was last updated at 15 June 2017.[18] PCNE creates guidelines and classification for DRPs to describe DRPs uniformly and serves as a process indicator in experimental studies.[19] The data were collected from the patient's medical records and a direct patient-pharmacist interview. A detailed medication review of retrospective data has been carried out for each patient. The number of DRPs per patient was calculated to measure the incidence of DRPs.

The clinical pharmacists used the latest pharmacy guidelines, BC Cancer Foundation Cancer Management Guidelines, to detect DRPs and standardized databases such as the British National Formulary (BNF), Medscape, Micromedex, Lexi-Comp Online, UpToDate and Drugs.com, to assist with the calculation of appropriate Body Surface Area (Mosteller equation), to assist with the calculation of appropriate doses based on creatinine clearance like carboplatin (Cockcroft-Gault Equation) and identify current data.

### *Data calculations*

The identified DRPs, causes, interventions, and outcomes were analyzed using GraphPad InStat (version 3.00 for Windows 95, GraphPad Software, San Diego California USA, www.graphpad.com). Individual and problem-specific analyses were performed separately because one patient may have exhibited more than one DRPs. Between-group differences were analyzed using the Chi-square test with Fisher's exact adjustment where appropriate for categorical variables and the t test for continuous variables. Mean age analyzed using Mann Whitney U test. Statistical significance was set at $p < 0.05$. All tests were two-tailed.

## Results

A total of 112 patients were admitted to the wards during the four months study period. Eleven patients who came out of our service with the reason that they continued treatment in another hospital or died were excluded. Clinical pharmacists reviewed all the patients and 55 patients (54.5%) had at least one DRP. A total of 251 DRPs were identified.

The mean patients' age was $59.15 \pm 12.09$ years. Age distribution varied by DRP status (p/0.009). Thirty-six point six percent of the patients were male. Gender and body surface area (BSA) distribution did not vary by DRP status (Table 1).

Patients with DRPs experienced a greater mean number of medications used than patients without DRPs ($10.8 \pm 3.6$ vs. $8.1 \pm 2.8$, p/0.009). The major four medication classes prescribed were antihypertensive agents (31.6%, p/0.04), herbals (31.6%, p/0.04), antidiabetics (17.8%, p/0.02), and antiplatelet agents (8.9%, p/0.03). Patients with DRPs exhibited a use of medications such as Proton-Pump Inhibitors (PPIs), Corticosteroids, Antihyperlipidemic agents, Thyroid hormones, Nonsteroidal Anti-Inflammatory Drugs (NSAIDs), diuretics, anticoagulants and antidepressants than patients without DRPs (Table 2).

Patients with DRPs exhibited a greater mean incidence of chronic conditions than patients without DRPs ($5.4 \pm 3.3$ vs. $3.43 \pm 2.0$, p/0.0001). The most common two conditions noted in patients were hypertension (49.1%, p/0.004), diabetes mellitus (32.7%, p/0.006) (Table 3).

Treatment effectiveness was the major type of DRPs (126 of 251 DRPs; 50.2%), followed by treatment safety (62; 24.7%) (Table 4).

Drug selection was the major cause of DRPs (104; 41.4%) followed by drug dispensing (44; 17.5%). A total of 249 DRP causes were identified (Table 5).

Simple linear regression analysis showed a positive or direct association between number of medications per patient and DRPs [correlation coefficient $(r) = 0.533$, $r^2 = 0.2840$, standard deviation of residuals from line $(Sy.x) = 1.640$, p\0.009] (Table 6).

A total of 691 proposed interventions were accepted. Most interventions occurred at the patient level (542; 78.4%) (Table 7). A total of 211 interventions accepted and 165 (78.2%) were fully implemented. A total of 214 DRPs were identified (Table 8), and 185 (86.4%) DRPs were totally solved, while 21 (9.8%) DRPs were partially solved, 5 (2.3%) DRPs were unsolved (Table 9).

## Discussion

Chemotherapy protocols in cancer treatment have been determined as detailed clinical trials. Furthermore, in complex drug treatments such as chemotherapy, there

**Table 1.** Baseline demographics according to DRP.

| | Total (n = 101) | | With DRP | | Without DRP | |
|---|---|---|---|---|---|---|
| Demographics | n | % | 55 | (54.5%) | 46 | (45.5%) |
| Mean age, years | 59.15 | ±12.09 | 62.22 | ±11.599 | 57.00 | ±11.595[a] |
| Sex, male | 37 | 36.6 | 21 | 38.2 | 16 | 34.8 |
| Sex, female | 64 | 63.4 | 34 | 61.8 | 30 | 65.2 |
| Mean BSA | 1.76 | ±0.17 | 1.74 | ±0.1811 | 1.76 | ±0.17 |
| Breast | 40 | 39.6 | 15 | 27.3 | 25 | 54.3 |
| Gastrointestinal | 29 | 28.7 | 18 | 32.7 | 11 | 23.9 |
| Genitourinary | 7 | 6.9 | 5 | 9.1 | 2 | 4.3 |
| Gynecology | 5 | 5 | 4 | 7.3 | 1 | 2.2 |
| Lung | 9 | 8.9 | 5 | 9.1 | 4 | 8.7 |
| Skin and melanoma | 0 | 0 | 0 | 0.0 | 0 | 0.0 |
| Lenfoma | 7 | 6.9 | 6 | 10.9 | 1 | 2.2 |
| Others | 4 | 4.0 | 2 | 3.6 | 2 | 4.3 |

DRP: drug-related problem.
[a]$p < 0.05$ significant than others.

**Table 2.** Medication-related characteristics in patients according to DRP.

| | Total (n = 101) | | With DRP | | Without DRP | |
|---|---|---|---|---|---|---|
| Medication-related characteristics | n | % | n | % | n | % |
| Antihypertensive agents | 32 | 31.6 | 22 | 40.0 | 10 | 21.7 |
| Antiarrhythmics | 3 | 2.9 | 2 | 3.6 | 1 | 2.1 |
| Diuretics | 4 | 3.9 | 3 | 5.4 | 1 | 2.1 |
| Antihyperlipidemic agents | 10 | 9.9 | 8 | 14.5 | 2 | 4.3 |
| Antidiabetic | 18 | 17.8 | 14 | 25.4 | 4 | 8.7[a] |
| Anticoagulants | 2 | 1.9 | 2 | 3.6 | 0 | 0.0 |
| Antiplatelet agents | 9 | 8.9 | 8 | 14.5 | 1 | 2.1[a] |
| Proton-pump inhibitors | 14 | 13.8 | 9 | 16.3 | 5 | 10.8 |
| Thyroid hormones | 10 | 9.9 | 4 | 7.2 | 6 | 13.0 |
| NSAIDs | 12 | 11.8 | 9 | 16.3 | 3 | 6.5 |
| Antibiotics | 1 | 0.9 | 0 | 0.0 | 1 | 2.1 |
| Antidepressants | 10 | 9.9 | 8 | 14.5 | 2 | 4.3 |
| Corticosteroids | 11 | 10.8 | 8 | 14.5 | 3 | 6.5 |
| Laxatives | 2 | 1.9 | 1 | 1.8 | 1 | 2.1 |
| Vitamins/minerals | 9 | 8.9 | 4 | 7.2 | 5 | 10.8 |
| Herbs | 32 | 31.6 | 29 | 52.7 | 3 | 6.5[a] |
| Alternative methods | 1 | 0.9 | 1 | 1.8 | 0 | 0.0 |

DRP: drug-related problem.
[a]$p < 0.05$ significant than others.

is a higher risk of experiencing DRPs.[20] Other agents need to be used to reduce or prevent the side effects of anti-cancer treatment. In addition to chemotherapy when the patients needed additional medications for chronic illnesses, the potential for DRPs is increasing.[13]

In this study, 102 patients were reviewed and 55 patients (54.5%) had at least one DRP. A total of 251 DRPs were identified. Patients with various age, sex, and cancer types, no significant relationship was seen. The most significant drug-related problem was

**Table 3.** Disease-related characteristics patients according to DRP.

| | Total (n = 101) | | With DRP | | Without DRP | |
|---|---|---|---|---|---|---|
| Disease-related characteristics | n | % | n | % | n | % |
| No additional disease | 39 | 38.6 | 14 | 25.5 | 25 | 54.3 |
| Hypertansion | 35 | 34.7 | 27 | 49.1 | 8 | 17.4 |
| Diabetes mellitus | 22 | 21.8 | 18 | 32.7 | 4 | 8.7 |
| Congestive heart failure | 0 | 0.0 | 0 | 0.0 | 0 | 0.0 |
| Renal failure | 1 | 1.0 | 1 | 1.8 | 0 | 0.0 |
| Coronary health disease | 0 | 0.0 | 0 | 0.0 | 0 | 0.0 |
| Hyperlipidemia | 12 | 11.9 | 2 | 3.6 | 10 | 21.7 |
| Asthma | 2 | 2.0 | 0 | 0.0 | 2 | 4.3 |
| Hypertrodism/hypotrodism | 11 | 10.9 | 5 | 9.1 | 6 | 13.0 |
| Other | 21 | 20.8 | 17 | 30.9 | 4 | 8.7 |

DRP: drug-related problem.

**Table 4.** Identified problems according to the PCNE DRP classification tool v8.01.

| | | Total number 251 | |
|---|---|---|---|
| Code V8.01 | Problems (also potential) | n | % |
| P1 | **Treatment effectiveness** | 126 | 50.2 |
| P1.2 | Effect of drug treatment not optimal | 76 | 30.3 |
| P1.3 | Untreated symptoms or indication | 50 | 19.9 |
| P2 | **Treatment safety** | 62 | 24.7 |
| P2.1 | Adverse drug event (possibly) occurring | 62 | 24.7[a] |
| P3 | **Others** | 63 | 25.1 |
| P3.2 | Unnecessary drug-treatment | 20 | 8.0 |
| P3.3 | Unclear problem/compliant. Further clarification necessary | 43 | 17.1[a] |

[a]$p < 0.05$ significant than others.

seen in cases of gastrointestinal (18; 32.7%) and breast cancers (15; 27.3%); however, 69; 68.3% of the patients who inserted the study were such as these cancer types, consequently it was not possible to establish a meaningful relationship between cancer types and DRPs. In the study, 62; 61.4% of our patients had additional diseases that are treated for beside to the chemotherapy drugs. In addition to the chemotherapy protocol, a mean of $4.5 \pm 2.9$ different medications were used for these diseases. This polypharmacy has an important and significant relation with DRPs. Polypharmacy related DRPs are informed to the prescriber (53; 7.7%).

The use of herbal medicines provided without physician consultation and without a prescription were higher at a significant level (32; 31.7%). 38; 15.3% of the total 249 DRPs observed were due to the inappropriate combination of drugs and herbal medications. Patients who are not adequately convinced and have not been educated about their protocol-related supportive care therapy, started to use herbal medications instead of their prescribed post-chemotherapy medications (45; 18.1%). The non-prescription and uncontrolled use of herbal medicines have resulted in 302; 43.7% of 691 planned interventions devoted to patient (drug) counseling and to family member/caregivers (166; 24%).

Another important DRP cause was that the medicines prescribed for both chemotherapy and additional chronic diseases were not used correctly and the patient did not obey the dose timing instructions (23; 9.2%) and missed given appointments (24; 9.6%). For example, a survey was conducted among patients on antiretroviral therapy in 15 health facilities in Uganda, reported a significant association between missing doses and missing appointments (p/0.0004).[21]

Several studies in chemotherapy of cancer patients showed a different mean number of DRPs per patient. For example, a cross-sectional study was conducted at Tikur Anbessa Specialized Hospital, reported 474 drug-related problems were identified in 274 patients among the 367 patients, which gave rise to a prevalence of

**Table 5.** Identified causes of DRPs according to the PCNE DRP classification tool v8.01.

| Code V8.01 | Problems (also potential) | Total number 251 | |
|---|---|---|---|
| | | n | % |
| C1 | **Drug selection** | 104 | 41.4 |
| C1.2 | Inappropriate drug (within guidelines but otherwise contra-indicated) | 2 | 0.8 |
| C1.4 | Inappropriate combination of drugs or drugs and herbal medication | 38 | 15.1 |
| C1.5 | Inappropriate duplication of therapeutic group or active ingredient | 1 | 0.4 |
| C1.6 | No drug treatment in spite of existing indication | 47 | 18.7 |
| C1.7 | Too many drugs prescribed for indication | 16 | 6.4 |
| C3 | **Dose selection** | 32 | 12.7 |
| C3.1 | Drug dose too low | 2 | 0.8 |
| C3.2 | Drug dose too high | 7 | 2.8 |
| C3.5 | Dose timing instructions wrong, unclear or missing | 23 | 9.2[a] |
| C5 | **Dispensing** | 44 | 17.5 |
| C5.2 | Necessary information not provided | 37 | 14.7[a] |
| C5.3 | Wrong drug, strength or dosage advised (OTC) | 7 | 2.8 |
| C6 | **Drug use/process** | 27 | 10.8 |
| C6.1 | Inappropriate timing of administration and/or dosing intervals | 24 | 9.6[a] |
| C6.4 | Drug not administered at all | 2 | 0.8 |
| C6.5 | Wrong drug administered | 1 | 0.4 |
| C7 | **Patient related** | 5 | 2.0 |
| C7.1 | Patient uses/takes less drug than prescribed or does not take the drug at all | 1 | 0.4 |
| C7.5 | Patient takes food that interacts | 3 | 1.2 |
| C7.7 | Inappropriate timing or dosing intervals | 1 | 0.4 |
| C8 | **Other** | 39 | 15.5 |
| C8.2 | Other cause; specify | 39 | 15.5[a] |

[a]$p < 0.05$ significant than others.

**Table 6.** Simple linear regression analysis of number of medications per patient and DRPs.

| n | Correlation | Sig. | | | | | |
|---|---|---|---|---|---|---|---|
| 17 | .533 | .28 | | | | | |
| | | | 95% Confidence interval of the difference | | | | |
| Mean | Std. deviation | Std. error mean | Lower | Upper | t | Df | Sig. (2-tailed) |
| −4.882 | 6.763 | 1.640 | −8.359 | −1.405 | −2.977 | 16 | 9 |

DRP: drug-related problem.

74.7%.[13] Another retrospective study was conducted at the National Cancer Centre Singapore (NCCS). The common DRP detected were potential drug interactions (36.4%), adverse drug events (31.7%). Adverse drug events detected were mostly associated with chemotherapy (91.3%) and patient education was the most common action taken (68.2%).[14] However, our study reviewed 102 patients, and 55 patients (54.5%) had at least one DRP. A total of 251 DRPs were identified. These studies varied between countries by patient number, study duration, the presence of a clinical pharmacist prior to the study, physician collaboration, and many other factors.

Age and gender may not be as important as the number of drugs prescribed as predictors of experiencing a DRP in patients with polypharmacy. The number of drugs used by the patient was a risk predictor for developing DRPs in patients.[15] In our study polypharmacy was obvious because the average number of medicines prescribed additionally to chemotherapy

protocols per patient was 4.5 ± 2.9. The number of the patients who had additionally chronic diseases was 62. A retrospective cross-sectional study was performed in an acute-care hospital in Singapore presented, results from patients with ADRs showed that the relative risk of geriatrics prescribed polypharmacy was 1.01.[16]

The three primary medication classes associated with DRPs were herbals + chemotherapy (52.7%), antihypertension agents + chemotherapy (40.0%), and antidiabetics + chemotheraphy (25.5%). Inappropriate combination of drugs or drugs and herbal medication was the main drug selection type DRP (15.3%) with no drug treatment in spite of existing indication (18.1%). At dispensing the chemotherapy stage necessary information not provided (14.9%) was the main significant cause of DRPs with inappropriate timing of administration and/or dosing intervals (9.2%).

Chemotherapy-related side effects were one of the major sub-causes of DRPs, which was not classified as a choice in the PCNE DRP classification tool v8.01. Therefore, these effects were included in "Other cause; specify" category (39, 15.7%). These side effects reported to authorities in the study (89; 12.9%). This mandatory inclusion of one of the major sub-causes of DRPs in the "Other cause; specify" category is a major defect in the PCNE DRP classification tool v8.01 for oncology patients.

The interventions in this study were highly accepted and implemented (fully implemented 78.2%, partly implemented 19.9%), which is comparable to the finding in previous studies of the implementation of CPS in different wards and clinics in the United States (95%).[22] Studies in Europe also reported CPS acceptance rate between 69 and 89%, which is considered high.[23–26]

**Table 7.** Proposed interventions according to the PCNE DRP classification tool v8.01.

| Code V8.01 | Planned interventions | Total number 691 | |
|---|---|---|---|
| | | n | % |
| I1 | **At prescriber level** | 53 | 7.7 |
| I1.1 | Prescriber informed only | 51 | 7.4 |
| I1.2 | Prescriber asked for information | 2 | 0.3 |
| I2 | **At patient level** | 542 | 78.4 |
| I2.1 | Patient (drug) counseling | 302 | 43.7[a] |
| I2.3 | Patient referred to prescriber | 74 | 10.7 |
| I2.4 | Spoken family member/caregiver | 166 | 24.0 |
| I3 | **At drug level** | 4 | 0.6 |
| I3.2 | Dosage changed to... | 1 | 0.1 |
| I3.5 | Drug stopped | 2 | 0.3 |
| I3.6 | New drug started | 1 | 0.1 |
| I4 | **Other** | 92 | 13.3 |
| I4.1 | Other intervention (specify) | 3 | 0.4 |
| I4.2 | Side effect reported to authorities | 89 | 12.9 |

[a]$p < 0.05$ significant than others.

**Table 9.** Status of the DRP according to the PCNE DRP classification tool v8.01.

| Code V8.01 | Status of the DRP | Total number 214 | |
|---|---|---|---|
| | | n | % |
| O0 | **Problem status unknown** | 3 | 1.4 |
| O0.1 | Problem status unknown | 3 | 1.4 |
| O1 | **Problem solved** | 185 | 86.4 |
| O1.1 | Problem total solved | 185 | 86.4[a] |
| O2 | Problem partially solved | 21 | 9.8 |
| O2.1 | Problem partly solved | 21 | 9.8 |
| O3 | Problem not solved | 5 | 2.3 |
| O3.1 | Problem not solved, lack of cooperation of patient | 1 | 0.5 |
| O3.2 | Problem not solved, lack of cooperation of prescriber | 1 | 0.5 |
| O3.4 | No need or possibility to solve problem | 3 | 1.4 |

DRP: drug-related problem.
[a]$p < 0.05$ significant than others.

**Table 8.** Intervention acceptance according to the PCNE DRP classification tool v8.01.

| Code V8.01 | Intervention acceptance | Total number 211 | |
|---|---|---|---|
| | | n | % |
| A1 | **Intervention accepted** | 211 | 100.0 |
| A1.1 | Intervention accepted and fully implemented | 165 | 78.2[a] |
| A1.2 | Intervention accepted and partly implemented | 42 | 19.9 |
| A1.3 | Intervention accepted but not implemented | 1 | 0.5 |
| A1.4 | Intervention accepted, implementation unknown | 3 | 1.4 |

[a]$p < 0.05$ significant than others.

However, the acceptance rate in Jordan was reported to be 69.4%.[27] The high rate of acceptance indicates that the interventions were relevant and highly effective for physicians and patients/familymembers/caregivers, especially in determining the treatment plan for patients and patient counseling. This high acceptance rate also supports the strong trust and professional relationship between physicians, patients, and pharmacists.

DRPs were totally solved at a very high rate (86.4%) as a result of providing quality and effective CPS in the study.

With the significant role of medications present in the treatment of cancer, the oncology pharmacist has become an essential part of the cancer care team. Oncology pharmacists should be actively involved in all aspects of cancer care from chemotherapy preparation, administration suggestion, safety controls, and patient education to clinical trials. Oncology pharmacists are active members of multidisciplinary cancer care teams. It is very important to measure the necessity and benefits of this service and convince the other team members to work together. In this study, the efficacy of oncology pharmacy with PCNE was determined statistically. Nevertheless, the use of PCNE in the field of oncology will contribute to the other oncology pharmacists to evaluate their clinics in a similar way. In addition, if a patient or caregiver has any questions about cancer drugs or chemotherapy protocols, the oncology pharmacists will be a valuable resource.

## Limitations

This study has the following limitations; first, the lack of a control group and studies with PCNE tool in oncology clinics for comparisons. Furthermore, a major limitation is being unable to evaluate the effect of interventions due to time constraint, and difficulty of acquiring patient information after the discharge from the hospital. Ultimately, the fact that the study was conducted in one centre also limits the generalization of findings. Thus, we recommend more controlled multi-centre studies where both updated treatment guidelines and clinical endpoint interventions are assessed to further define the incidence of DRPs and the role of clinical pharmacist services.

## Conclusion

Chemotherapy itself is a polypharmacy. The high prevalence of DRP was been noticed in cancer treatments, along with the medications used pre-and post-chemotherapy with additional chronic diseases. However, CPS may have optimized therapy effectiveness and prevented patients from DRPs. The oncology pharmacist interventions were highly accepted by physicians and patients. Significant reduction in DRPs will promote collaboration between physicians and clinical pharmacists and encourage the multidisciplinary work. These may indicate the presence of a great opportunity and need to optimize and implement CPS in oncology clinics in other Northern Cyprus hospitals.

### Ethics approval

The Near East University Institutional Review Board approved this study (2017-51/463).

### Declaration of conflicting interests

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