RESEARCH ARTICLE

Editorial Process: Submission:06/14/2025 Acceptance:05/01/2026 Published:05/20/2026

Evaluating Cancer Patients' Knowledge of Chemotherapy: Identifying Communication Gaps and Medication Errors in General Hospital of Thamar City

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Abstract

Objective: In Yemen, there is a notable lack of data regarding cancer patients' knowledge of chemotherapy and the communication gaps that may contribute to medication errors. To our knowledge, this is the first study to assess cancer patients' understanding of chemotherapy in Thamar City, aiming to evaluate their knowledge, communication practices, and the impact of these factors on treatment-related errors. **Methods:** A cross-sectional study was conducted between December 2024 and March 2025 at the General Hospital in Thamar City. Adult cancer patients who were either undergoing chemotherapy or receiving follow-up care were included. Data were collected through structured, face-to-face interviews conducted by trained clinical pharmacists using a validated, culturally adapted questionnaire. The survey covered socio-demographic characteristics, chemotherapy knowledge, adherence practices, communication behaviors, preferred information sources, and experiences with medication errors. Data were analyzed using SPSS version 28. **Results:** Of the 209 cancer patients surveyed, the majority were female (65.1%), aged over 50 (58.4%), and unemployed (90.0%). While 87.1% demonstrated good knowledge about chemotherapy, only 9.1% could name their medications, and misunderstandings about managing side effects remained. Despite high treatment adherence, communication challenges were prevalent-71.8% found medical terminology difficult to understand, and 24.4% experienced medication errors. Knowledge levels were significantly associated with gender, education, and employment status ($p < 0.05$). **Conclusion:** While most cancer patients demonstrated good overall knowledge about chemotherapy, significant challenges persist particularly in medication-specific awareness and side effect management. Communication gaps, including unclear explanations and limited patient engagement, were associated with medication errors. Enhancing communication practices and delivering patient-centered education can play a crucial role in reducing errors and supporting optimal treatment outcomes.

Keywords: Cancer patients- chemotherapy- knowledge- communication gaps- medical errors- Yemen

Asian Pac J Cancer Prev, **27 (5)**, 1679-1688

Introduction

Cancer remains a major global health challenge, with nearly 20 million new cases and 9.7 million deaths reported in 2022; by 2050, the annual incidence is projected to rise to 35 million, underscoring the urgent need for effective prevention and control strategies worldwide [1]. In Yemen, cancer is a significant public health problem, and the size of the problem and underlying risk factors is not yet well studied. The true epidemiological profile of cancer in Yemen is unknown due to limited resources for pathology, the scarcity, and quality of medical records, and limited epidemiology resources. However, the crude incidence rate (CIR) of all cancers was reported as 55.2 per 100,000 in 2020 according to the Global Cancer Observatory (GCO) database [2].

Cancer treatment involves multiple modalities, including chemotherapy, radiation, immunotherapy, and surgery [3, 4]. Chemotherapy, one of the primary treatments for cancer, uses chemical agents to destroy cancer cells, though it impacts both the psychological and physiological aspects of patients, leading to side effects such as nausea, vomiting, pain, stress, and anxiety [5]. Patients undergoing chemotherapy may receive treatment for months or years, facing adverse effects that can negatively impact their quality of life [6, 7].

Providing cancer patients with adequate knowledge about their treatment its purpose, potential benefits, and side effects can alleviate some of their anxieties [7–9]. In addition, this knowledge enables patients to adhere to treatment regimens, make informed decisions, and manage side effects effectively [10,11]. However, knowledge

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levels vary, and there are often gaps in understanding, which can hinder effective treatment and care [12, 13].

These knowledge gaps not only impact treatment adherence and outcomes but can also increase the risk of medication errors (MEs) the most common type of medical error and a major threat to patient safety [14–16]. Inadequate knowledge, whether on the part of healthcare providers or patients, is a key contributor to such errors, particularly during prescribing, dispensing, administration, and monitoring stages [16–19]. Poor communication between providers and patients can further contribute to medication errors and other negative outcomes [16]. Conversely, strong provider–patient communication fosters trust, reduces anxiety, improves patient satisfaction, and lowers the risk of litigation [16, 20–22].

Given the lack of data on cancer patients' knowledge of chemotherapy in Yemen, it is crucial to assess their knowledge and identify communication gaps that could contribute to medication errors. This study represents, to our knowledge, the first effort to explore cancer patients' knowledge of chemotherapy both nationwide and specifically in Thamar City. It aims to evaluate patients' understanding of their treatment at the General Hospital of Thamar City, focusing on communication barriers, potential medication errors. Understanding these factors is essential for improving patient education, addressing gaps in information delivery, and developing targeted educational support services. Empowering patients with the knowledge they need will enhance their ability to manage treatment effectively and improve the overall quality of care they receive.

Materials and Methods

Study Design and Setting

A cross-sectional study was conducted between December 2024 and March 2025 at the oncology unit of the General Hospital in Thamar city, which provides free cancer care services. The study population consisted of adult cancer patients (aged over 18) who had been diagnosed with cancer and were either currently receiving chemotherapy or had completed treatment but continued follow-up visits with their physicians at the hospital. Exclusion criteria included cognitive impairment, terminal illness, being under 18 years of age, or lack of awareness of their cancer diagnosis.

A convenience sampling method was used, whereby patients who met the inclusion criteria were invited to participate during their visits to the oncology unit. Informed consent was obtained prior to data collection. Structured face-to-face interviews were conducted by a trained clinical pharmacist, with each session lasting approximately 25-30 minutes. Interviews took place during both morning and afternoon shifts to ensure broad patient inclusion. Data collection was supplemented by a review of hospital records. This approach ensured that all patients, regardless of literacy level, could meaningfully participate.

Sample Size calculation

According to patient records, around 456 individuals are admitted each year to the oncology unit at the General Hospital in Thamar City. Using the Raosoft® sample size calculator [23] and assuming a binomial distribution with a 95% confidence level, a 5% margin of error, and a 50% response distribution, the minimum required sample size was determined to be 209 participants.

Study Instrument

The questionnaire used in this study was developed following a comprehensive review of the literature [5, 24, 25] to ensure it covered all critical domains of chemotherapy knowledge and communication issues. Content validity was ensured through review by a panel consisting of three clinical pharmacy experts, along with two general practitioners and nurses from the facility. They evaluated each section of the questionnaire and provided feedback, which was incorporated to enhance clarity and relevance.

To ensure the questionnaire was suitable for the local population, a forward–backward translation process was used. Initially, the questionnaire was translated from English into Arabic, then independently back-translated into English to verify consistency and accuracy. Discrepancies identified during this process were addressed following a pilot study, which led to minor revisions in two questions to enhance cultural relevance and clarity. The final tool was administered in a structured interview format, allowing for consistent data collection and enabling participants to express their perspectives regardless of literacy level.

Several response formats utilized, including multiple choice, "Yes" or "No", multiple checkboxes, the Likert scale, and open-ended items.

The survey consisted of five sections. The first covered socio-demographic and medical history, including age, gender, education, occupation, marital status, cancer type, diagnosis year and stage, and treatment status. The second assessed patients' knowledge of chemotherapy, including treatment awareness, purpose, side effects, administration methods, and management strategies. The third evaluated patients' adherence practices and communication behaviors, such as attending sessions, following instructions, seeking advice for side effects, and interacting with healthcare providers. The fourth explored preferred sources and channels for chemotherapy-related information, along with communication challenges like complex terminology, information overload, and mistrust in the healthcare system. The final section addressed the impact of communication gaps on medication errors, detailing patients' experiences, types and causes of errors, healthcare team responses, and reported consequences ranging from no impact to hospitalization.

To assess patients' knowledge of chemotherapy and its management, a scoring system was developed based on their responses to key questions in Table 2. Each correct or informed response was assigned one point. For single-answer questions (e.g., being informed about the chemotherapy regimen, awareness of side effects, or knowledge of administration routes), a "yes"

answer received one point. For multiple-choice items, participants earned one point for each correct option selected, including goals of chemotherapy (maximum of 3 points), known side effects (up to 4 points), and methods for managing adverse effects such as nausea, fatigue, hair loss, mouth sores, and infection risk (one point per correct method). The total possible score was 16. Participants scoring 8 or above were categorized as having adequate knowledge, while those scoring below 8 were considered to have inadequate knowledge.

Statistical analysis

All collected data were entered and analyzed using the Statistical Package for the Social Sciences (SPSS) version 28 (SPSS Inc., Chicago, IL, USA). Descriptive statistics, including frequencies and percentages, were used to summarize socio-demographic variables, medical history, knowledge levels, and patient practices related to chemotherapy. Categorical variables were compared using the Chi-square test to assess associations between patients' knowledge levels and variables such as age, gender, education level, and cancer stage. Logistic regression analysis was performed to identify predictors of good chemotherapy knowledge and inadequate side effect management. A significance level of $p < 0.05$ was considered statistically significant throughout the analysis.

Results

Table 1 summarizes the socio-demographic characteristics and medical history of the patients who participated in this study. Most patients were aged 50 years or older (58.4%), followed by those aged 30–49 years (30.6%), and a smaller proportion aged 18–29 years (11.0%). Females made up a larger portion of the sample (65.1%) compared to males (34.9%). A significant number of patients were illiterate (59.8%), and the vast majority (90.0%) were unemployed. In terms of marital status, 79.9% were married, 12.0% widowed, 6.7% single, and 1.4% divorced.

Concerning medical history, breast cancer was the most frequently reported diagnosis (18.7%), followed by stomach cancer (11.0%) and uterine cancer (10.0%). Other cancer types included lymphatic gland (5.7%), colon (5.3%), pancreas (4.8%), liver (4.3%), and ovarian (4.3%). Less common cancers such as bone, mouth, blood, lung, and rectum were each reported by fewer than 4% of patients. Additionally, 18.6% reported having other unspecified types of cancer.

Regarding the time since diagnosis, 36.4% had been diagnosed within the past year, while 25.4% were diagnosed 1–2 years ago, and 25.8% had been living with their diagnosis for more than three years. Most patients (72.7%) were diagnosed at stage 1, with smaller percentages at stage 2 (16.7%), stage 3 (4.3%), and stage 4 (6.2%). At the time of data collection, 84.2% were still receiving treatment, whereas 15.8% had completed their treatment.

Participants' knowledge of chemotherapy and its management is summarized in Table 2. A vast majority (91.9%) reported being informed about their chemotherapy regimen prior to starting treatment. Most participants were aware of the goals of chemotherapy, with 63.6% identifying symptom relief, 45.0% recognizing cancer cure, and 14.4% indicating slowing cancer progression as main objectives. However, 21.1% expressed uncertainty regarding its purpose. Notably, only 9.1% knew the names of the medications they received, indicating limited awareness of treatment specifics. Almost all participants (99.5%) were aware of chemotherapy side effects, with fatigue (96.7%), nausea and vomiting (91.4%), weakened immunity (88.0%), and hair loss (75.1%) being the most commonly recognized. A majority (93.3%) understood how chemotherapy is administered.

Table 1. Socio-Demographic Characteristics and Medical History of the Patients (n =209).

Item		Frequency	Percent
Age in Years	18 - 29	23	11
	30 - 49	64	30.6
	50	122	58.4
Gender	Male	73	34.9
	Female	136	65.1
Education Level	Illiterate	125	59.8
	Literate	84	40.2
Current Occupation	Unemployed	188	90
	Employee	21	10
Marital Status	Married	167	79.9
	Widowed	25	12
	Divorced	3	1.4
	Single	14	6.7
Type of Cancer	Breast Cancer	39	18.7
	Stomach Cancer	23	11
	Uterus Cancer	21	10
	Lymphatic glands Cancer	12	5.7
	Colon Cancer	11	5.3
	Pancreas Cancer	10	4.8
	Liver Cancer	9	4.3
	Ovarian Cancer	9	4.3
	Bone Cancer	8	3.8
	Mouth Cancer	8	3.8
	Blood Cancer	7	3.3
	Lung Cancer	7	3.3
	Rectum Cancer	7	3.3
	Others	38	18.6
	Total	209	100
Date of diagnosis in Years	Less than a year	76	36.4
	1 to 2 years	53	25.4
	2 to 3 years	26	12.4
	More than 3 years	54	25.8
Stage at Diagnosis	Stage 1	152	72.7
	Stage 2	35	16.7
	Stage 3	9	4.3
	Stage 4	13	6.2
Treatment Status	Undergoing treatment	176	84.2
	Completed treatment	33	15.8

In terms of side effect management, 63.6% correctly identified taking anti-nausea medication before meals to manage nausea, though 36.4% still opted for incorrect practices like avoiding food and water. Regarding fatigue, while 39.7% suggested mild activity and rest, 62.2% incorrectly believed that avoiding all physical activity was best. For hair loss, 69.9% recommended using gentle shampoos and covering the scalp, though a small percentage chose ineffective or inappropriate methods. In managing mouth sores, most (60.7%) suggested using anti-fungal oral gel, while 33.5% recommended saline rinses. When asked about infection risk reduction, 92.8% correctly cited hygiene and avoiding crowds, though a minority mentioned unsafe practices like unsupervised antibiotic use.

Overall, 87.1% of participants demonstrated good knowledge of chemotherapy and its side effects, while 12.9% were classified as having poor knowledge (Table 2). This indicates a generally high awareness level, although some misconceptions persist, especially regarding side effect management.

Participants' practices related to chemotherapy treatment were assessed, as shown in Table 3. The vast majority (94.3%) reported that they always attended their chemotherapy sessions as scheduled, with only a small percentage attending sometimes (4.8%) or rarely (1.0%). In terms of adherence to medical instructions for managing chemotherapy side effects—such as taking prescribed medications and getting adequate rest—90.4% of participants reported always following their doctor's instructions, while 8.1% did so sometimes and 1.4% rarely complied. When asked about their response to experiencing side effects, only 20.6% reported always seeking medical advice. However, the majority (77.5%) stated that they sought medical advice sometimes, and 1.9% rarely did so. Regarding communication with the healthcare team during chemotherapy, 21.1% of participants reported that they always asked questions or raised concerns. The majority (76.6%) communicated sometimes, while 1.9% rarely and 0.5% never engaged in communication with their care team.

Communication and its impact on medication errors among cancer patients was evident in the responses of participants, as nearly all (99.5%) acknowledged that effective interaction with healthcare providers is essential to their treatment. An equal proportion believed that providers should always clearly explain the diagnosis and available treatment options. Furthermore, when asked about the importance of clear communication with doctors or nurses, the vast majority (97.6%) rated it as very important, while only a small fraction (2.4%) considered it somewhat important.

Table 4 summarizes the participants' preferences for receiving information about chemotherapy and highlights the communication challenges they encountered. The vast majority (98.1%) preferred to receive information from a specialist doctor, while pharmacists and nurses were chosen by only 1.0% and 0.5% of participants, respectively. Most patients (68.9%) sought information before beginning treatment, whereas fewer did so after treatment had started (2.9%) or ended (4.3%). Nearly one-quarter (23.4%) were open to receiving information at any available time. In terms of delivery, 92.8% preferred verbal explanations, while written pamphlets (10.5%), online sources (1.9%), and educational videos (1.4%) were less favored. Despite these preferences, several communication challenges were reported. A significant number of participants (71.8%) found medical terminology too complex, and 54.1% felt they lacked sufficient time with healthcare providers. Additionally, 25.4% were overwhelmed by too much information, and 7.7% reported a lack of trust in their providers. These findings underscore the need for more patient-centered communication strategies and accessible educational materials.

Table 5 presents the impact of communication gaps on the occurrence of medication errors among chemotherapy patients. Nearly one-quarter of participants (24.4%) reported experiencing at least one medication error, with the most common being missed doses (15.8%), followed by taking medication at the wrong time (4.8%), stopping treatment prematurely (4.3%), and receiving the wrong dose (1.9%). Participants identified several contributing factors to these errors, with complex medical terminology being the most frequently cited cause (27.3%), followed by miscommunication among healthcare providers (11.5%) and insufficient time to ask questions (9.1%). Only a few attributed errors to confusing instructions (5.3%). While 74.5% of those who experienced a medication error felt the healthcare team appropriately addressed the issue, the consequences varied—58.8% reported no adverse outcomes, whereas others experienced worsening symptoms (37.2%), new side effects (11.8%), or required hospitalization (23.5%). These findings emphasize the critical role of clear, accessible, and timely communication in preventing medication-related errors and improving treatment safety.

Table 6 presents the associations between patient characteristics and overall knowledge levels regarding chemotherapy. The analysis revealed that gender, education level, and employment status were significantly associated with the overall knowledge level among cancer patients undergoing chemotherapy. Female participants were more likely to have good knowledge compared to males (91.2% vs. 79.5%, $p = 0.016$), and logistic regression confirmed this with males having significantly lower odds of good knowledge (OR = 0.374, 95% CI: 0.165–0.850, $p = 0.019$). Similarly, illiterate patients demonstrated a significantly higher level of knowledge compared to literate ones (91.2% vs. 81.0%, $p = 0.030$), with the literate group showing lower odds of good knowledge (OR = 0.410, 95% CI: 0.180–0.935, $p = 0.034$). Employment status also showed a significant association; working patients had a higher proportion of good knowledge than non-working ones (88.8% vs. 61.5%, $p = 0.005$), with the odds of good knowledge significantly lower among non-working patients (OR = 0.202, 95% CI: 0.061–0.673, $p = 0.009$).

Regarding the duration since diagnosis, although the overall chi-square test was not significant ($p = 0.185$), patients diagnosed 1–2 years prior had significantly higher odds of good knowledge compared to those

Table 2. Patients' Knowledge Toward Chemotherapy (n =209)

Item	Frequency	Percent
Were you informed about the full chemotherapy regimen before starting treatment?		
Yes *	192	-91.9
No	16	7.7
Not sure	1	0.5
What do you think is the main goal of chemotherapy? (Multiple choices)		
Symptom relief *	133	63.6
Slow cancer progression*	30	14.4
Cure cancer*	94	45
I don't know	44	21.1
Do you know the names of the medications given to you in chemotherapy?		
Yes*	19	-9.1
No	188	90
Are you aware of the potential side effects of chemotherapy?		
Yes*	208	99.5
No	1	0.5
If yes, what side effects do you know of? (Multiple choices)		
Fatigue*	202	96.7
Nausea and vomiting*	191	91.4
Weakened immunity*	184	88
Hair loss*	157	75.1
Do you know how chemotherapy is administered (e.g., intravenously or orally)?		
Yes*	195	93.3
No	10	4.8
Not sure	4	1.9
Knowledge on managing side effects		
How can nausea and vomiting be managed at home? (Multiple choices)		
Take prescribed anti-nausea medication before meals*	133	63.6
Avoid food and water until nausea stops	76	36.4
Do intense exercise to reduce symptoms	1	0.5
What is the recommended way to manage fatigue and weakness? (Multiple choices)		
Rest as needed while staying mildly active*	83	39.7
Avoid any physical activity	130	62.2
Skip meals to conserve energy	6	2.9
What can help reduce hair loss during chemotherapy?		
Use gentle shampoos and cover the scalp*	146	69.9
Avoid washing hair entirely	18	8.6
Take over-the-counter hair growth pills	2	1
Others (only water or using Henna)	43	14.5
What can help manage mouth sores caused by chemotherapy?		
Regular rinsing with saline solution*	70	33.5
Brushing teeth harshly	11	5.3
Drinking only acidic beverages	1	0.5
Others (use anti-fungal oral gel)	127	60.7
What can help reduce infection risk due to low blood cell counts?		
Regular hand washing and avoiding crowded places*	194	92.8
Taking antibiotics without doctor's advice	13	6.2
Completely avoiding food and drinks	1	0.5
Others (stay at home)	1	0.5

Table 3. Patients' Practices Related to Chemotherapy Adherence and Communication Behaviors (n = 209)

Item	Always	Sometimes	Rarely	Never
How regularly do you attend chemotherapy sessions as scheduled?	197 (94.30%)	10 (4.80%)	2 (1)	0
Do you follow your doctor's instructions for managing chemotherapy side effects (e.g., medications, rest)?	189 (90.40%)	17 (8.10%)	3 (1.40%)	0
How often do you seek medical advice when experiencing side effects?	43 (20.60%)	162 (77.50%)	4 (1.90%)	0
Do you communicate with the healthcare team to ask questions or raise concerns during chemotherapy?	44 (21.10%)	160 (76.60%)	4 (1.90%)	1 (0.5)

Table 4. Patients' Preferred Information Sources, Delivery Channels, and Communication Challenges During Chemotherapy (n =209)

Item	Frequency	Percent
What is your preferred source of information?		
Specialist doctor	205	98.1
Pharmacist	2	1
Nurse	1	0.5
Visual/audio media	1	0.5
When do you prefer to search or ask for information?		
Before starting treatment	144	68.9
After starting treatment	6	2.9
After finishing treatment	9	4.3
Anytime available	49	23.4
How do you prefer to receive medication-related information?		
Verbal explanation	194	92.8
Written pamphlets	22	10.5
Online sources	4	1.9
Educational videos	3	1.4
Communication Challenges		
What challenges do you face during your chemotherapy treatment? (Multiple choices)		
Medical terms are too complex	150	71.8
Too much information from providers	53	25.4
Lack of trust in healthcare providers	16	7.7
Not enough time with providers	113	54.1

Table 5. Impact of Communication Gaps on Chemotherapy-Related Medication Errors (n =209)

Item	Frequency	Percent
Have you experienced any Medication Errors		
Yes	51	24.4
No	158	75.6
If yes, what are the type of Medication Errors? (Multiple choices)		
Missed a dose	33	15.8
Wrong dose	4	1.9
Took medication at the wrong time	10	4.8
Stopped medication before completing treatment	9	4.3
In your opinion, what was the main cause of the medication error? (Multiple choices)		
Confusing instructions	11	5.3
Miscommunication among healthcare providers	24	11.5
Not enough time to ask questions	19	9.1
Complex medical terminology	57	27.3
Did the healthcare team address the medication error properly after it was reported?		
Yes	38	74.5
No	13	25.5
What were the consequences of the medication error? (Multiple choices)		
No consequences	30	58.8
Worsening of symptoms	19	37.2
New side effects appeared	6	11.8
Hospitalization	12	23.5

diagnosed less than a year ago (OR = 3.763, 95% CI: 1.024–13.829, p = 0.046). Other factors, including age, marital status, cancer stage, treatment status, and history of medication errors, were examined but did not show statistically significant associations with knowledge levels in either the chi-square or univariate logistic regression analyses.

Discussion

This study the first of its kind in Yemen and specifically in Thamar City assessed cancer patients' knowledge of chemotherapy and communication gaps linked to medication errors. Most patients demonstrated good understanding of chemotherapy and its side effects. However, despite high adherence, about 24% experienced medication errors due to issues like complex medical language and limited provider time.

This study found that breast cancer accounts for one of the highest prevalence rates among the Yemeni population (18.7%), aligning with global research that highlights its widespread impact and reinforcing its significance as a major public health concern worldwide [1, 26].In this study, 87.1% of participants demonstrated overall good knowledge of chemotherapy and its side effects, while 12.9% showed poor knowledge figures notably higher than those reported in a study from Bangladesh, where only 46.4% of patients were knowledgeable [24]. However, despite this encouraging general awareness, only 9.1% of patients could name the chemotherapy drugs they received, indicating limited awareness of treatment specifics. This contrasts with findings from a study conducted in Maryland, USA, by Huynh and Trovato (2014), where 91% of patients claimed to understand their treatment, yet only 52.2% were able to identify their specific chemotherapy agents [12]. The notable

Table 6. Factors Influencing the Overall Knowledge Level among Patients Receiving Chemotherapy (n =209)

Factors		Overall Knowledge Level				Chi-Square Tests	Univariate logistic regression	
		Good		Poor				
		n	(%)	n	(%)	p-Value	Odd ratio (95% C.I.)	p-Value
Age in years						0.993		
	18-29	20	87.0	3	13.0		1 (reference)	0.993
	30-49	56	87.5	8	12.5		1.050 (0. 253, 4.352)	0. 946
	50	106	86.9	16	13.1		0. 994 (0. 265, 3.729)	
Gender						0.016*		
	Female	124	91.2	12	8.8		1	
	Male	58	79.5	15	20.5		0.374 (0.165, 0.850)	0.019*
Education level						0.030*		
	Illiterate	114	91.2	11	8.8		1	
	Literate	68	81.0	16	19.0		0.410 (0.180, 0.935)	0.034*
Maternal status						0.198		
	Married	141	84.4	26	15.6			
	Divorced	24	96.0	1	4.0			
	Widow	3	100.0	0	0.0			
	Single	14	100.0	0	0.0			
Work						0.005*		
	Yes	174	88.8	22	11.2		1	
	No	8	61.5	5	38.5		0.202 (0.061, 0.673)	0.009*
Diagnosis date (Years)						0.185		
	< a year	62	81.4	14	18.6		1	0. 216
	1-2	50	94.3	3	5.7		3.763 (1.024, 13.829)	0.046
	2-3	22	84.4	4	15.6		1.242 (0.369, 4.177)	0.726
	> 3 Years	48	88.9	6	11.1		1.806 (0.646, 5.049)	0.26
Stages						0.353		
	1st	133	87.5	19	12.5		1	
	2nd	32	69.6	3	30.4		1.524 (0.425, 5.466)	0.518
	3rd	7	77.8	2	22.2		0. 500 (0.097, 2.586)	0. 408
	4th	10	76.9	3	23.1		0.476 (0.120, 1.887)	0. 291
Treatment status						0.201		
	Undergoing treatment	151	85.8	15	14.2		1	
	Completed	31	93.9	2	6.1		2.566 (0.578, 11.401)	0.215
Medication errors						0.097		
	Yes	48	94.1	3	5.9		1	
	No	134	84.8	24	15.2		0.349 (0.101, 1.212)	0.097

OR, Odd ratio; Star sign (*) and bold text indicate significant variable

discrepancy between perceived understanding and actual knowledge of treatment details observed both in the present study and in the Maryland study [12] highlights a global gap in precise therapeutic communication and underscores the critical need for more effective patient education regarding chemotherapy specifics.

Concerning knowledge of treatment goals, most participants believed the primary aim of chemotherapy was symptom relief, followed by curing cancer. In contrast, a qualitative study from Malta found that all patients, regardless of their treatment intent, believed that the main objective of chemotherapy was to achieve a cure [11].

Almost all participants (99.5%) in this study recognized chemotherapy side effects, with fatigue (96.7%), nausea and vomiting (91.4%), weakened immunity (88.0%), and hair loss (75.1%) being the most frequently mentioned. Similarly, research from India found that both patients and their family caregivers had a high level of awareness regarding side effects [27]. In contrast, a study conducted in Tanzania reported that only 40.7% of patients (88 individuals) were aware of chemotherapy side effects, indicating differing levels of awareness across regions [28]. However, despite this high awareness in the current

study, many patients lacked a full understanding of how to manage these effects appropriately. While a majority used recommended strategies such as taking anti-nausea medication (63.6%), maintaining good hygiene to prevent infections (92.8%), and using oral gels for mouth sores (60.7%) misconceptions persisted. For instance, 36.4% believed avoiding food could help with nausea, and 62.2% thought complete rest was the best way to cope with fatigue. This contrasts with findings from other studies that reported a higher level of patient understanding in managing chemotherapy-related side effects [5, 12].

Encouragingly, in the current study, the majority of participants consistently attended their chemotherapy sessions (94.3%) and adhered to medical instructions (90.4%), reflecting a similarly positive trend observed in another study where patients reported regular hospital visits for chemotherapy [24]. However, only 20.6% sought medical advice for side effects, and just 21.1% maintained consistent communication with their healthcare providers. These figures are considerably lower than those observed in other studies for instance, one study reported that 89.6% of patients who had received formal education maintained regular communication with their oncology team [12], while another found that 77.3% had been directly counseled by physicians [28].

Communication quality emerged as a pivotal factor. The current study underscores that nearly all participants (99.5%) recognized clear communication as essential to cancer treatment, aligning with findings from multiple studies [11, 29] which emphasized the value of receiving clear and sufficient information. However, as noted in prior research [29–31] ,excessive technical details can overwhelm patients, making gradual, personalized information delivery preferable. Like previous studies [31, 32], patients valued clear explanations and time for questions. Furthermore, most participants (68.9%) preferred to receive chemotherapy information before starting treatment, aligning with Fee-Schroeder et al. [33], who suggested that patient education is ideally delivered prior to treatment initiation. However, this contrasts with findings from another study [11], where patients reported feeling overwhelmed by the volume of information given at the start of their treatment.

Around 24.4% of participants reported experiencing at least one medication error, with missed doses being the most frequently reported type (15.8%). This finding falls within the range of chemotherapy medication error rates identified in a systematic review by Ashokkumar, which varied from 0.004% to 41.6% across different studies [34]. Delving deeper into the contributing factors, our study revealed that 27.3% of participants attributed these errors to complex medical terminology highlighting communication barriers as a significant root cause. This observation is supported by multiple studies [10, 35, 36] that reported patient dissatisfaction stemming from unclear or incomplete information. These insights underscore the critical need for healthcare providers to adopt plain language and ensure patients fully understand treatment instructions, especially in high-risk contexts such as chemotherapy administration. Additionally, miscommunication between providers (11.5%) and insufficient time for patients to ask questions (9.1%) further reveal communication failures that can lead to harm. These challenges are consistent with studies emphasizing the importance of clear, well-explained information [29, 37, 38] and the value of active listening and empathy in provider–patient interactions [35, 38, 39]. When patients are rushed or unable to seek clarification, the likelihood of errors rises, threatening their safety.

Consequences of poor communication were evident: 37.2% of patients experienced symptom worsening, and 23.5% required hospitalization following a medication error. These outcomes underscore the real-world implications of communication failures and align with prior research advocating for structured, simplified information delivery to promote safety and adherence [10, 29, 37, 38].

The present study identified significant associations between several patient characteristics and their overall knowledge about chemotherapy. Notably, female patients demonstrated significantly better knowledge compared to males, consistent with previous research suggesting women may engage more actively in health-related information seeking and communication [40, 41]. This gender disparity highlights the need for targeted educational interventions aimed at improving chemotherapy knowledge among male patients to support better treatment adherence and outcomes.

Interestingly, the study revealed that illiterate patients exhibited higher knowledge levels than their literate counterparts, which may seem counterintuitive. In contrast, a study by Stacker et. al found a statistically significant association between patients' educational levels and their knowledge about chemotherapy, indicating that individuals with higher education levels possessed greater understanding of their treatment [42]. In addition, research focusing on women with breast cancer highlighted that education is essential for patients to obtain and retain chemotherapy knowledge [8]. Our finding could reflect that illiterate patients receive more tailored, perhaps verbal or visual, education from healthcare providers or caregivers to compensate for literacy barriers, leading to better comprehension in this group. Alternatively, it could indicate that literate patients, despite their reading abilities, may not be receiving or retaining information effectively. This emphasizes the importance of adapting educational materials and communication methods to patients' literacy levels to ensure effective knowledge transfer for all.

Employment status also emerged as a significant factor, with working patients showing higher knowledge levels than non-working individuals. Employment may correlate with greater access to resources, social support, or motivation to stay informed about their treatment. A related study found significantly higher self-care efficacy among employed patients, suggesting that employment may indirectly enhance treatment understanding [43]. These insights support the provision of additional educational and support services to unemployed patients to reduce disparities in treatment comprehension

Other factors, such as age, marital status, cancer stage, treatment status, and history of medication errors, did not show significant associations with chemotherapy

knowledge. This indicates that demographic and clinical variables alone may not predict patient understanding as strongly as social and experiential factors. Healthcare providers should thus consider individual patient characteristics and experiences when designing educational interventions.

Overall, these findings highlight the complex interplay between patient demographics, social factors, and knowledge acquisition. They emphasize the necessity for personalized, clear, and ongoing communication strategies to improve patient education and ultimately support better chemotherapy management and safety.

This study provides important insights into cancer patients' knowledge, communication patterns, and chemotherapy-related medication errors in Thamar, Yemen; however, several limitations should be noted. Cross-sectional design prevents causal interpretation, and the use of convenience sampling from a single public hospital may limit generalizability. Although structured interviews reduce literacy barriers, responses may still be affected by recall bias and occasional misinterpretation. Additionally, while the questionnaire underwent expert review and forward–backward translation to ensure clarity and cultural relevance, numerical measures of validity and reliability such as the Content Validity Index (CVI), Cronbach's alpha, and construct validity analyses (EFA/CFA) were not performed.

Despite these limitations, the study offers valuable baseline evidence from a resource-limited setting and highlights urgent areas for improving patient education, strengthening provider–patient communication, and reducing chemotherapy-related medication errors.

In conclusion, this study highlights generally high levels of chemotherapy knowledge among cancer patients, with strong treatment adherence. However, critical gaps remain in understanding specific medications and managing side effects effectively. Communication barriers especially complex terminology and limited provider time contributed to medication errors. Targeted education strategies and improved patient-provider communication are essential to enhance treatment safety and patient outcomes.

Author Contribution Statement

Sayida Al-Jamei. Supervision; Conceptualization; Writing- original draft; Formal analys. Adel H. Khalil. Conceptualization; Investigation; Writing- original draft; Formal analysis supervised the project. Khaled A. Al-Akhali Writing – review & editing; Resources. Faiz Sakran Writing – review & editing; Resources

Acknowledgements

The authors sincerely thank all the patients who participated in this study.

Ethical considerations

The research adhered to the principles outlined in the Declaration of Helsinki and received approval from the Ethics Committee of Lebanese International University (LIU/UREC/2024/003).

Conflict of interest

None

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