

Associations of healthcare providers' awareness, perception, and knowledge of chemotherapy-induced cognitive impairment and their intentions to provide information about it to patients

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Abstract. – **OBJECTIVE:** Most recent oncology studies support the existence of chemotherapy-induced cognitive impairment. This study's objective was to evaluate the power of healthcare providers' knowledge, awareness, and perception of memory impairment caused by chemotherapeutic agents, as predictors of their intentions to convey information about this side effect to patients.

MATERIALS AND METHODS: A cross-sectional online survey with 32 questions and seven domains was distributed. The domains included questions about healthcare providers' behaviors, norms, attitudes, awareness, perceptions, and knowledge about chemotherapeutic agent-induced cognitive impairment and their intentions to inform patients about these side effects. Descriptive and inferential statistics were calculated to analyze associations.

RESULTS: A total of 207 healthcare providers completed the survey. Their mean age was 31 (± 7.8) years and most of them were physicians (43.5%). Positive relationships were found between healthcare providers' attitudes ($\beta=0.239$, $p<0.001$), subjective norms ($\beta=0.219$, $p<0.001$), behavioral control ($\beta=0.284$, $p<0.001$), and intentions to provide information to patients. Their awareness was positively associated with their age ($\beta=0.127$, $p<0.001$), and their (or their relatives') receipt of chemotherapeutic agents ($\beta=1.363$, $p=0.04$); however, a negative relationship was found with physician specialists ($\beta=-2.659$, $p<0.001$) and Saudi nationality ($\beta=-2.919$, $p<0.001$). A negative correlation was found between healthcare givers' perceptions and physician specialists ($\beta=-1.487$, $p=0.003$), and a positive association with participants' total knowledge ($\beta=0.765$, $p<0.001$). Univariate linear regression analysis of participants' knowledge

showed a negative relationship with Saudi nationality ($\beta=-0.835$, $p<0.001$) and physician specialists ($\beta=-0.519$, $p=0.003$).

CONCLUSIONS: Providers' low scores on awareness, perceptions, and knowledge of these side effects of treatment highlight a need for strategic educational programs that meet patients' needs and improve their quality of life.

Key Words:

Chemo-brain, Cognitive impairment, Chemotherapy, Memory impairment, Healthcare providers, Awareness, Perception, Knowledge, Intention.

Abbreviations

CI, Confidence interval; SD, Standard Deviation.

Introduction

According to the World Health Organization, nearly 10 million people died of cancer in 2020¹. Chemotherapy and radiation therapy are chemotherapeutic agents that have been effective in helping patients with cancer overcome this fatal disease². These treatments have been administered aggressively and their benefits accompany their downside, such as chemo brain (cognitive impairment due to chemotherapeutic agents), which can have a long-term impact³. The side effects of chemotherapy are not limited to fatigue, hair loss, and cardiotoxicity; they also include cognitive disturbances in patients treated with chemotherapy for years after treatment^{4,5}.

Studies^{6,7} on cognitive changes and adjuvant chemotherapy have been published since 1970, with an incidence ranging from 16% to 75%, although systematic investigations did not appear until 1990.

Scholars⁸ have reported cognitive decline in 23% of patients with breast cancer who received adjuvant chemotherapy with Doxorubicin and Cyclophosphamide, alone or followed by Taxane. However, the mechanism by which chemotherapeutic regimens trigger alterations in cognitive function has not been elucidated. Various routes of action have been proposed^{3,6}. According to Cancer Research United Kingdom, aggressive treatment causes “chemo brain”³, which can be viewed as dementia, and includes cognitive impairments, such as memory loss, impaired judgment, and even slowed thinking⁴.

Chemo-brain phenomena vary widely from patient to patient⁷. Depending on the type of cancer and the medications used, the mental consequences can appear immediately after starting therapy, years after starting therapy, or never appear, and they can affect memory and/or attention and be subtle, or acute⁹. Numerous factors affecting an oncology patient can conceal the true origin of symptoms, which affect 15% to 75% of cancer patients¹⁰. Currently, the most effective way to manage this problem is to detect symptoms as soon as possible, discuss them with the treating oncologist as soon as they appear, and discuss therapeutic options^{11,12}.

Many recent articles on cancer survivors with cognitive impairment have been published¹³⁻¹⁵. In a study with 872 young adults, 53.3% of the cancer survivors reported that their exposure to chemotherapy treatment interfered with their ability to perform mental tasks. Even those exposed to radiation therapy reported mental impairment¹⁶.

Disorientation and memory and attention losses, language difficulties, and the cognitive sequelae of chemotherapy have only recently been objectively evaluated using brain imaging studies and other tests¹⁷. To date, some oncologists attribute this “brain fog” to the patient’s confusion, age, surgery, or sequelae of early menopause induced by some medications¹⁸. However, the cognitive problems were usually caused by chemotherapy. Unfortunately, many specialists agree that oncologists have devoted excessive attention to this problem¹⁹. According to the American Cancer Society, chemotherapy is beneficial as it increases the patient’s life span, despite the long-term effects of treatment²⁰. Cancer treatments

have side effects, which when combined with the disease’s effects, cause temporary or permanent damage. In a pilot study of two groups of healthcare workers (nurses and technicians and doctors and biologists; N=30) with breast cancer, the nurses/technicians had significantly lower scores on the Work Ability Index. This was due in part to their inability to perform job-related tasks (e.g., manual lifting of patients) because of limited mobility in their upper limbs from treatment, which also slowed their return to work. Women of lower working classes often require a longer period of rest from work and experience a greater loss of working capacity²¹. If healthcare providers overlook these risks because of the increased lifespan brought about by chemotherapy, they might ignore other catastrophic consequences for patients (e.g., unemployment and poverty). Patients’ challenges to adjusting to these more effective treatments have multiplied, and if these challenges are not dealt with adequately, they can lead to psychological comorbidities, such as anxiety and depression, which are the most common symptoms of patients with cancer. Patients with cancer in Malaysia reported using several coping mechanisms with various degrees of effectiveness; religious coping and family support were cited as most effective coping mechanisms²². However, beginning with the diagnosis of cancer, family and friends of the patient experience emotions, such as fear, sadness, and anger as they go through a grieving process, knowing the patient could be gone suddenly even though the patient is still alive. Identifying the patients’ and the family’s perceived social support and their levels of hope can facilitate the patient’s acceptance of treatment, speedy recovery, and promote morale and motivation in the patient to continue treatment²³. Support systems are extremely important for the above reasons; nevertheless, in a study of 152 first- and second-degree relatives who were caregivers of hospitalized patients with cancer, 25.6% had moderate to severe depression²⁴.

A broad range of side effects (i.e., cognitive) of chemotherapy for different cancer types has been documented²⁵. The prevalence of chemotherapy-related cognitive impairment has risen to 30% or higher among patients receiving treatment²⁶. Previous literature has suggested that chemotherapy may complicate the recovery process because of the length of treatment and effects on the nervous system. Given these drawbacks to treatment, it seems that either healthcare workers lack adequate knowledge and therefore, the ability to

pass on this information to patients, or patients lack interest in learning about and understanding the treatment they receive^{27,28}.

Community-based knowledge of cancer and its treatment is lacking and has led to stigmatization of patients with cancer. The community tends to fear them, and some even think they can contract cancer through socialization. This has made awareness of cancer significant within communities, as stigmatization indicates a comprehension gap between healthcare providers and the community. Specific measures are needed to improve awareness through coordination and communication in the healthcare system. According to the American Cancer Society, improving communication in the healthcare system could improve treatment results and correct unrealistic perceptions of treatment. This will be possible when cancer patients and healthcare providers understand each other²⁴. Interventions for chemotherapy-induced chemo brain cannot be effective if all responses come from only one person. Instead, multiple parties should implement them. Healthcare providers who have knowledge of chemotherapy and its long-term adverse effects can take action only when they are united²⁹. Memory impairment affects different aspects of daily living, such as students' school performance and workers' functioning, which might endanger individuals and their surroundings. Currently, healthcare providers' knowledge, awareness, and perception of memory impairment due to chemotherapeutic agents are crucial for conveying important treatment information to either the patient or their caregiver. Lack of healthcare providers' awareness might lead to a patient's distress or anguish but contribute to the confidence of the healthcare provider. Hence, our objectives were to assess providers' awareness, perception, and knowledge of information on chemotherapeutic agent-inducing memory loss and their intentions to provide such crucial information to the patient.

Materials and Methods

Study Design and Data Sources

A cross-sectional survey-based observational study was conducted to explore healthcare providers' overall understanding of the effects of chemotherapeutic agents on memory, including their perceptiveness and recognition of chemo-brain phenomena, and their behavior and attitudes towards these side effects. Data were

collected from September to October 2020 using a self-administered questionnaire *via* an online survey system.

Participants

An invitation and survey link were distributed through social media to all licensed healthcare providers currently working at a health institution in Saudi Arabia. The estimated time to complete the questionnaire was 15 minutes. Once respondents opened the survey link, an informed consent form appeared, requesting their participation. If they agreed, the website transferred them to the survey. Participation was anonymous and voluntary. When the survey was completed, the system transferred the respondent to the end of the program and posted an appreciation note. Participants were allowed to stop at any time without providing a reason. Participants who finished the survey were presented with a link; once they clicked it, the system automatically transferred them to another website that was not linked to the survey for privacy concerns. On the delinked website, the participant was able to provide their phone number, and choose whether to receive 15 Saudi Riyals (4.00 USD) as a gift or donate it to a charity. Ethical approval was obtained from the National Committee of Bio-Ethics before the beginning of the data collection process. Only members of the study's research group had access to view the information; the information was stored in the principal investigator's office. Participants' privacy and confidentiality were protected; no identifiers or personal information were collected or stored, including the participant's name.

Survey Design

This survey was a validated, pretested questionnaire. The knowledge section was adapted from two instruments developed in the United States: the University of Alabama Birmingham Alzheimer's Disease Knowledge Test for Health Professionals³⁰, and the Alzheimer's Disease Knowledge Test³¹. The behavior and attitude questions were designed based on the Theory of Planned Behavior³²; other questions on awareness, perception and overall understanding of Alzheimer's were adapted from multiple studies^{8,33-35}. The investigators interviewed healthcare providers from different medical specialties, including epidemiologists, surgeons, clinical pharmacists, and oncologists, using a think-aloud method. Investigators also conducted interviews with individual respondents. After each inter-

view, participants were given a copy of our survey and asked to tell us how they felt about it.

Outcome Variables

This study analyzed several variables: (1) intention, (2) awareness, (3) perception, (4) and knowledge of healthcare providers. Intention was assessed with three items presented as statements based on the Theory of Planned Behavior³² (e.g., “I expect to provide information to the patient or caregiver about memory effects due to chemotherapy treatment”) and measured on a 7-point Likert scale ranging from 1 (strongly disagree) to 7 (strongly agree), with responses indicating participants’ level of agreement with the statement. Awareness was measured using a 5-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree), with items, such as “Chemotherapeutic agents increase the risk of cognitive impairment,” and close-ended questions adapted from several studies (“Do you think dementia caused by chemotherapeutic agents is a permanent disease?”) requiring Yes/No answers^{35,36}. Questions related to participants’ perceptions were also adapted from several studies (e.g., “Chemotherapeutic agents strongly affect the memory of patients”) and measured on a Likert scale^{35,37,38}. Knowledge was divided into two categories: epidemiology and causes. All the multiple-choice questions included an “I don’t know” option to eliminate guessing and were adapted from the Alabama University Birmingham Alzheimer’s Disease Knowledge Test³⁰ and the Alzheimer’s Disease Knowledge Test for Health Professionals³¹.

Independent Variables

The covariates in our study were demographics, chemotherapy exposure, attitude, behavior control, and subjective norms. In the first section of the survey, participants were asked to provide information related to the following covariates: (1) gender, (2) year of birth, (3) nationality, (4) marital status, (5) specialty, (6) education, (7) work experience, (8) healthcare center location, (9) monthly income (10) behavioral control, (11) subjective norms, and (12) attitude. Gender was categorized as male or female, and age was biased on their year of birth. The reason for recording their birth year was to ensure accuracy and avoid randomization. The most common nationalities in Saudi Arabia were included: Saudi, Kuwaiti, Egyptian, British, Syrian, Indian, Pakistani, Philippines, and Malaysian. “Other” was

added as it was impossible to include every nationality. Marital status was categorized as married, never married, widowed, or divorced. The most common healthcare specialties were classified as nurse, pharmacist, physician, laboratory specialist, and other. We asked physicians to indicate their specialty area as family medicine, internal medicine, surgeon, oncologist, neurologist, or radiologist. Education attainment was categorized by participants’ last degree (diploma, bachelor, master’s, doctoral, residency, or fellowship). Work experience in years was measured as a continuous variable, then divided into two categories based on participants’ answers (ten years or less, more than ten years) to assess whether its duration had an effect. Healthcare center locations were urban, rural, or suburban areas. Income was analyzed as a continuous variable (per 1000). Chemotherapy treatment exposure among participants or any of their relatives was measured using a dichotomous Yes/No response. Behavioral control, subjective norms, and attitude were assessed using the Theory of Planned Behavior²⁸. Items on behavioral control (“I am confident I could provide information to the patient or caregiver about memory impairment due to a chemotherapeutic agent if I wanted to”) and subjective norms (“It is expected of me that I give information to the patient or caregiver about memory impairment due to chemotherapeutic agents”) were measured on a 7-point Likert scale ranging from 1 (strongly agree) to 7 (strongly disagree). Questions about attitude were measured using an evaluative scale, (e.g., “Providing information to the patient or the caregiver about memory impairment due to chemotherapeutic agents is: harmful/beneficial, good/bad, pleasant/unpleasant, or worthless/useful”), with all options rated on a 7-point scale.

Statistical Analysis

Data were analyzed using Stata Software for Statistics v.16 (SPSS, Chicago, IL, USA). Descriptive statistics were reported as means and frequencies. Demographic and clinical information and responses to closed-ended questions were summarized in frequency tables. Both univariate and multivariate linear regression analyses were conducted to analyze relationships between variables and their degree of linearity. The 95% confidence interval (CI) was calculated, and $p < 0.05$ was considered statistically significant. All data collected were coded and entered using Microsoft Excel (2019).

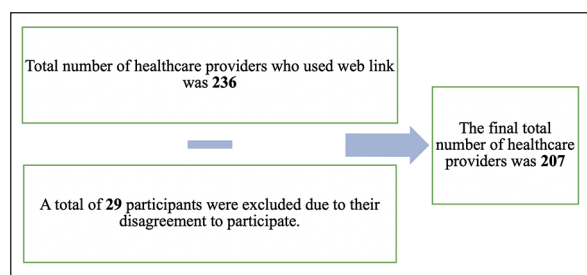


Figure 1. Flowchart of the selection of participants.

207 completed the questionnaire, resulting in a response rate of 87.7%. Non-response bias was tested. Figure 1 illustrates the sample selection.

Results

Characteristics of the Sample

A total of 236 healthcare providers accessed the on-line survey through a link. Of these,

Sociodemographic Characteristics

Table I presents participants' sociodemographic characteristics (continuous variables). The mean age of the 207 participants was 31 years. The (total) mean monthly income was approximately 16000 SAR (1 US\$= 3.75 SAR), and the mean number of years since participants' last degree was eight (Table I). Table II presents participants' demographic characteristics (categorical variables). The majority of participants were males (51.2%), and the dominant nationality was Saudi Arabian (77.8%), followed by

Table I. Participants' age, years since graduation, and monthly income (continuous variables).

Variable	Mean	Standard deviation	Minimum	Maximum
Age (years)	31.47	7.82	21	75
Years since graduation	8.34	7.59	1	35
Monthly income (SAR)	16052.4	10880.8	2000	65000

Table II. Demographic characteristics of participants (categorical variables).

Variable	Categories	Frequency (%) (N = 207)
Gender	Male	106 (51.2%)
	Female	101 (48.7%)
Nationality	Saudi	161 (77.8%)
	Filipino	16 (7.7%)
	Malaysian	9 (4.4%)
	Indian	7 (3.4%)
	Other	14 (6.8%)
Marital status	Married	86 (41.6%)
	Never married	111 (53.6%)
	Divorced	8 (3.9%)
	Widowed	2 (1%)
Specialty	Physician	90 (43.5%)
	Nurse	59 (28.5%)
	Pharmacist	42 (20.3%)
	Other	16 (7.7%)
Educational level	Bachelor or equal	120 (58%)
	Residency program	38 (18.4%)
	Doctoral degree (PhD)	16 (7.7%)
	Diploma	12 (5.8%)
	Master's degree	12 (5.8%)
	Fellowship	7 (3.4%)
	Professor	2 (1%)
Work experience	Ten years or less	163 (80.6%)
	More than ten years	44 (21.7%)
Healthcare center location	Urban	176 (85%)
	Rural	16 (7.7%)
	Suburban	15 (7.3%)

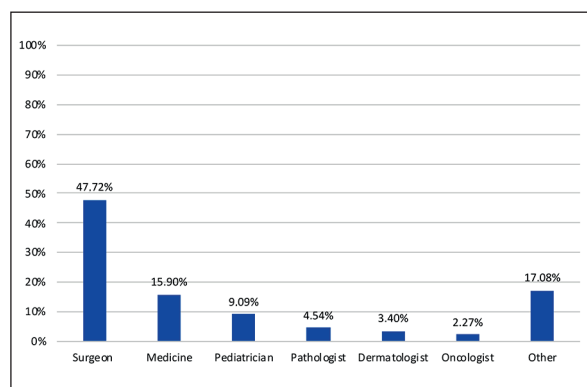


Figure 2. Physician specialties (N = 90).

Filipino (7.7%), and other mixed nationalities. Among the 207 participants, 43.5% were physicians, followed by 28.5% who were nurses, 20.3% who were pharmacists, and 7.7% who were associated with other medical specialties. The physicians were further categorized to assess by medical specialty (Table II). Figure 2 shows physicians' medical specialties, with surgeons (47.7%) being the most common specialty among the 90 physician participants, followed by those in internal medicine (15.9%), pediatrics (9%), and pathology (4.5%). Unsurprisingly, the majority of participants reported that neither they nor their family members had prior chemotherapy treatment (Figure 3).

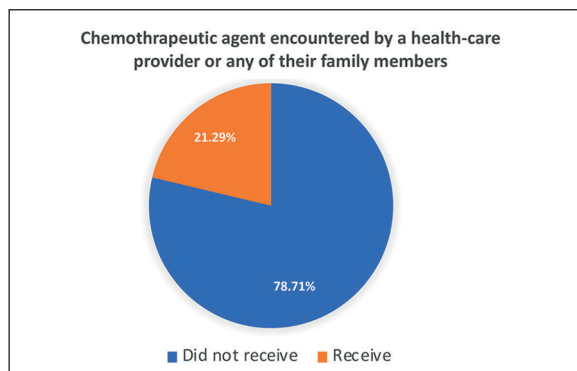


Figure 3. Incidence of chemotherapy treatment of health-care providers or any member of their family (N=207).

Intention to Convey Information to Patients about Impaired Memory Due to Chemotherapeutic Agents

Attitudes, subjective norms, and behavioral control showed significant positive associations with participants' intention to provide information about chemotherapeutic agents. The first positive association was found between health-care providers' intentions and attitudes related to conveying information to patients ($\beta=0.261$, $p<0.001$). The intention to provide information with subjective norms ($\beta=0.219$, $p<0.001$) and behavioral control ($\beta=0.284$, $p<0.001$) were positively related (Table III). A multivariate regression analysis of healthcare providers' intentions

Table III. Univariate linear regression analysis of data on the intention of healthcare providers to convey information about memory impairment due to chemotherapeutic agents.

Variable	Beta coefficient	95% Confidence Interval		p-value
		Lower	Upper	
Male gender	0.287	-0.751	1.326	0.586
Mean age	-0.035	-0.102	0.032	0.306
Monthly income (per 1000)	0.016	-0.001	0.001	0.909
Saudi nationality	-0.059	-1.308	1.190	0.926
Marital status	-0.284	-1.355	0.786	0.601
Physician specialty	-0.606	-1.651	0.437	0.253
Mean years of work experience	-0.030	-0.100	0.040	0.397
Urban	0.852	-0.613	2.316	0.253
Graduation year	0.001	-0.001	0.003	0.271
Healthcare providers or their relatives receiving chemotherapy	0.173	-1.096	1.443	0.788
Total knowledge	-0.007	-0.384	0.369	0.968
Total attitude	0.261	0.157	0.365	< 0.0001***
Total subjective norms	0.219	0.106	0.332	< 0.0001***
Total behavioral control	0.284	0.141	0.428	< 0.0001***

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

Table IV. Multivariate linear regression analysis of data on the intention of healthcare providers to convey information about memory impairment due to chemotherapeutic agents.

Variable	Beta coefficient	95% Confidence Interval		p-value
		Lower	Upper	
Total attitude of healthcare providers	0.239	0.140	0.339	< 0.0001***
Total subjective norms of healthcare providers	0.161	0.052	0.270	0.004**
Total behavioral control of healthcare providers	0.208	0.069	0.347	0.004**

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

revealed that their attitude was positively associated with conveying treatment information to patients ($\beta=0.239$, $p<0.001$). Similarly, a positive relationship was found between healthcare provider’s subjective norms ($\beta=0.161$, $p=0.004$) and behavioral control ($\beta=0.208$, $p=0.004$). All other variables were kept constant (Table IV).

Awareness of Information About Chemotherapeutic Agents

Participants’ awareness was measured using univariate analysis (Table V). The results showed that healthcare providers’ awareness was positively associated with their age ($\beta=0.127$, $p<0.001$), and their (or their relatives’) receipt of chemotherapeutic agents ($\beta=1.363$, $p=0.04$). On the other hand, awareness was negatively associated with physician specialty ($\beta=-2.659$, $p<0.001$) and Saudi nationality ($\beta= -2.919$, $p<0.001$) (Table V). When the multivariate regression analysis of participants’ awareness of chemotherapy-induced memory impairment was conducted, the results revealed that the physician participants showed a negative relationship with awareness ($\beta= -0.203$, $p=0.008$); conversely, participants’ knowledge was positively associated with their awareness ($\beta=0.437$, $p=0.042$) (Table VI).

Perceptions of Information Regarding Chemotherapeutic Agents

The participants’ perceptions of information about chemotherapeutic agents were negatively associated with physician specialty, ($\beta= -1.487$, $p=0.003$) (Table VII). Knowledge was positively associated with perception ($\beta=0.845$, $p<0.001$). The results of a multivariate regression analysis revealed that physician specialty was negatively associated with perceptions of information about chemotherapeutic agents ($\beta= -1.059$, $p=0.029$), whereas participants knowledge was positively associated with their perceptions of it ($\beta=0.765$, $p<0.001$) (Table VIII).

Knowledge about Information Regarding Chemotherapeutic Agents

Participants’ knowledge of information regarding chemotherapeutic agents is shown in Table IX. A negative relationship was found between Saudi nationality and knowledge ($\beta= -0.835$, $p<0.001$). Moreover, another negative association was found between participant physicians and knowledge about chemotherapeutic agents ($\beta= -0.519$, $p=0.003$). The results of the multivariate regression analysis (Table X) of the data from only Saudi nationals showed a negative associ-

Table V. Univariate linear regression analysis of participants’ awareness of information about chemotherapeutic agent-induced- memory impairment.

Variable	Beta coefficient	95% Confidence Interval		p-value
		Lower	Upper	
Male gender	-0.904	-2.009	0.201	0.109
Mean age	0.127	0.060	0.194	< 0.001***
Monthly income (per 1000)	-0.001	-0.001	0.001	0.148
Saudi nationality	-2.919	-4.195	-1.643	< 0.001***
Physician specialty	-2.659	-3.720	-1.599	< 0.001***
Healthcare providers or their relatives receiving chemotherapy	1.363	0.017	2.710	0.047*

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

Table VI. Multivariate linear regression analysis of healthcare providers' awareness of chemotherapy-induced memory impairment.

Variable	Beta coefficient	95% Confidence Interval		p-value
		Lower	Upper	
Male gender	0.513	-0.744	1.770	0.421
Mean age	0.055	-0.034	0.144	0.224
Monthly income (per 1000)	0.006	-0.001	0.001	0.840
Saudi nationality	-1.193	-2.883	0.497	0.165
Physician specialty	-1.863	-3.291	-0.434	0.011*
Healthcare providers or their relatives receiving chemotherapy	0.827	-0.634	2.289	0.265
Total knowledge	0.437	0.016	0.858	0.042*

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

Table VII. Univariate linear regression analysis of participants' perceptions of information about chemotherapy-induced memory impairment.

Variable	Beta coefficient	95% Confidence Interval		p-value
		Lower	Upper	
Male gender	-0.172	-0.817	1.161	0.732
Mean age	-0.001	-0.067	0.049	0.757
Monthly income (per 1000)	0.001	-0.001	0.001	0.817
Saudi nationality	-0.400	-1.589	0.788	0.507
Married status	-0.030	-1.047	0.987	0.953
Graduation year	-0.001	-0.003	0.001	0.158
Physician specialty	-1.487	-2.463	-0.510	0.003**
Total knowledge	0.845	0.459	1.232	< 0.001***
Healthcare providers' or their relatives receiving chemotherapy	0.031	-0.032	0.093	0.343

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

ation with knowledge about chemotherapeutic agent-induced memory impairment ($\beta = -0.676$, $p = 0.04$).

Table XI summarizes participants' responses to knowledge-related questions, as we calculated their overall scores, and then, separately calculated the subscale score for the knowledge questions. Overall, healthcare providers from a variety of specialties answered 21% of the questions correctly. According to the two subscales

with knowledge questions, 21.8% of questions on the epidemiology subscale and 20.2% of those on the cause subscale were answered correctly. The most common errors on the epidemiology subscale were underestimations of the numbers of people that will develop dementia symptoms after chemotherapy treatment. On the cause scale, participants' assumptions of confirmatory procedures to assess chemotherapy patients for dementia were surprisingly incorrect.

Table VIII. Multivariate linear regression analysis of healthcare providers' perceptions of chemotherapy-induced memory impairment.

Variable	Beta coefficient	95% Confidence Interval		p-value
		Lower	Upper	
Physician specialty	-1.059	-2.010	-0.108	0.029*
Total knowledge	0.765	0.424	1.107	< 0.001***

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

Table IX. Univariate linear regression analysis of participants' knowledge of information about chemotherapy-induced memory impairment.

Variable	Beta coefficient	95% Confidence Interval		p-value
		Lower	Upper	
Male gender	-0.400	-0.776	0.025	0.037
Mean age	-0.027	-0.003	0.051	0.028*
Monthly income (per 1000)	-0.001	-0.001	0.007	0.092
Marital status	-0.309	-0.642	0.024	0.069
Saudi nationality	-0.835	-1.277	-0.393	< 0.001***
Graduation year	0.001	-0.001	0.001	0.870
Physician specialty	-0.519	-0.895	-0.143	0.007**
Healthcare providers or their relatives receiving chemotherapy	-0.153	-0.617	0.310	0.514

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

Discussion

This study explored the intentions of healthcare providers to convey information about memory impairment due to chemotherapeutic agents to their patients. Multivariate linear regression analysis showed healthcare providers' attitudes, subjective norms, and behavioral control predicted their intention to convey information to patients about memory impairment. Healthcare providers' total knowledge and physician specialties were positively associated with awareness. Similarly, the associations of participants' perceptions with total knowledge and physician specialty were significant. Another linear regression analysis found a statistically significant negative association between participants' knowledge and Saudi nationality.

Most previous studies on chemo-brain phenomena have been conducted with cancer survivors. We recognized a need to assess whether healthcare providers' awareness, perceptions,

and knowledge of chemotherapy-induced memory impairment could predict their intention to provide this information to patients.

This study found significant positive associations of the participants' attitudes, subjective norms, and behavioral control related to the patients' side effects with their intention to provide information to them. This finding indicates that participants were willing to provide this information whether or not it affected the patient's decision to proceed with chemotherapy. This result is consistent with those of a study conducted with nurses that examined the relationship of their attitudes and subjective norms with their intention to provide oral care to patients receiving chemotherapy and found that both attitudes and subjective norms were significant predictors of behavioral intention³⁹. In another study, the attitudes and behavioral control of oncologists and oncology healthcare providers were associated with their intention to promote physical activity among cancer survivors⁴⁰. Correlation studies^{41,42}

Table X. Multivariate linear regression analysis of the knowledge of healthcare providers about chemotherapy-induced memory impairment.

Variable	Beta coefficient	95% Confidence Interval		p-value
		Lower	Upper	
Male gender	-0.223	-0.714	0.269	0.372
Mean age	0.001	-0.034	0.035	0.970
Monthly income (Per 1000)	-0.005	-0.001	0.001	0.672
Saudi nationality	-0.676	-1.337	-0.015	0.04*
Physician specialty	-0.203	-0.771	0.364	0.480

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

Table XI. Number and percentage of respondents with correct answers on the knowledge subscale (n=207).

Item	Correct
1. Among 100 cancer patients, what is the number of people that you expect to develop the symptoms of dementia due to chemotherapy: A. 20-45% B. 50-75% C. Less than 20% D. More than 75%*	8 (4%)
2. The prevalence of dementia among cancer patients is likely to: A. Decrease slightly B. Remain approximately the same C. Increase slightly D. Nearly double*	8 (4%)
3. What are the risk factors for developing dementia among patients undergoing chemotherapy: A. Sleep disruption B. Pain due to treatment and the presence of other medical conditions C. Anxiety D. All of the above*	116 (57.4%)
4. Patients undergoing chemotherapy are more susceptible to memory-related issues: A. Highly B. Moderately* C. Neutral D. Low	81 (40.1%)
5. Chemotherapy affects brain size by: A. Increasing brain size B. Decreasing brain size* C. Chemotherapy does not affect brain size	41 (20.3%)
6. Patients undergoing chemotherapy, such as methotrexate often exhibit a significant decline in: A. Intellectual function* B. Concentration C. Visual-motor performance	27 (13.3%)
7. Which of the following procedures is necessary to confirm symptoms related to dementia among patients undergoing chemotherapy: A. Mini-Mental State Examination B. Computed Tomography scan of the brain C. Blood test D. Post-mortem*	4 (2%)
8. The following is not considered part of the early evaluation of a person with dementia undergoing cancer treatment: A. Serum electrolytes B. Folate and Vitamin B levels* C. Thyroid functioning test D. Protein electrophoresis	34 (16.8%)
9. The following clinical findings leads to the differentiation of dementia from Alzheimer's disease: A. Word finding tests B. Short-term loss of visual memory* C. Incidence of depression D. A stepwise course of the disease	59 (29.2%)

*Correct answers. All questions included an "I don't know" option.

have also found associations of healthcare workers' attitudes and beliefs with their intention to proceed further with their actions.

Healthcare providers' expertise and experiences are no doubt relevant to information sharing^{43,44}. However, information sharing by healthcare providers remains challenging and the process of designing successful pathways to educate their patients cannot be overstated; it is a

fundamental aspect of achieving an optimal level of management and assuring implementation of the highest quality of care⁴⁵. The research literature suggests that inadequate information sharing among clinicians affects the quality of care, and it has caused a series of major, even fatal, medical errors⁴⁶⁻⁴⁸. Effective information sharing is beneficial for both clinicians and patients. A recent study⁴⁹ of nurses reported an association

between sufficient information sharing and job satisfaction. Recognition of the issue and the use of effective communication skills to convey valid information to the patient is crucial for the creation of effective interventions to enhance patient care, and ultimately, quality of life⁴⁵.

Awareness of chemotherapeutic agent-induced memory impairment was positively associated with participants' total knowledge, but it was negatively associated with physician specialty. The positive association of participants' total knowledge with their awareness of chemotherapeutic-induced medical impairment is consistent with previous findings, as the increased awareness of this issue would be a direct result of greater knowledge and vice versa^{50,51}. However, the negative association among the physician participants was predictable. Scholars⁵² reported the absence of awareness of the risks of chemotherapy among healthcare providers, including physicians. The majority of physician respondents in the present study did not specialize in oncology; consequently, information about chemotherapy-induced memory impairment was not a top priority. Therefore, an evidence-based educational program on memory impairment for physicians across specialties is needed. Physicians' awareness is necessary for planning rehabilitation and collaborating with cancer survivors through information sharing⁵³. Patients are less aware of the side effects of chemotherapy, which requires physicians' expertise and knowledge, and is another reason for developing awareness⁵⁴. Finally, patients' increased awareness of side effects through physicians' disease management is directly related to patient care and informed consent⁵⁵.

Healthcare providers' perceptions can be used to improve quality care, informed decision making, and communication between patients and healthcare providers⁵⁶. In our study, participants' perception was negatively associated with physician specialty and positively associated with knowledge. A recent study⁵⁷ underscored the significance of the relationship between knowledge and perception regarding information management. A 2021 study⁵⁸ conducted in a tertiary teaching hospital in Nepal concluded that the knowledge of healthcare providers is paramount whereby a positive perception complements knowledge and increases the likelihood of patient recovery. Failure to perceive potential problems when discussing the prognosis of a disease with a patient can affect a physician's credibility,

leading to a patient's loss of confidence after realizing that the physician's information is not accurate or complete⁵⁹. Physicians' perceptions understanding along with effective communication and discussion of the patient's condition can directly affect a patient's perception⁶⁰. Patients' perceptions and understanding of chemotherapy side effects can be enhanced through proper education provided by oncology pharmacists, nurses, and physicians⁶¹.

In our study, health-care providers' knowledge was negatively associated with participants' age, Saudi nationality, and physician specialty. These results are consistent with similar studies with Saudi participants^{38,62} and physicians of other nationalities⁶³. The current outcomes highlight the need for projects at the undergraduate and postgraduate levels to facilitate our medical practice related to chemo-brain phenomena in the Saudi framework. This plan is supported by the large portion of respondents' reports that the absence of instruction was the greatest barrier to their execution of chemo-brain education in their clinical practice. Lack of knowledge can be overcome through cooperation among clinical programs, the ministry, and professional associations that could update undergraduate programs and develop students' knowledge base. However, as physicians are considered the healthcare providers most likely to interact with patients about their treatment, they should convey their knowledge to the patient as they provide informed treatment, resulting in patient satisfaction, improved outcomes, and information reception. Information sharing about chemotherapy's side effects promotes patient-doctor discussions and realistic treatment, leading to patient satisfaction⁶⁴. A recent study⁶² reported an association of patients' knowledge of chemotherapy's side effects with positive outcomes.

The overall knowledge of cognitive impairment due to chemotherapy treatment among this study's healthcare providers was surprisingly poor. To the authors' knowledge, this is the first study to apply the Theory of Planned Behavior to this clinical issue. Many factors could have contributed to participants' lack of knowledge about such a critical issue among cancer survivors. Lack of time and/or education about chemo-brain phenomena contributed to the scarcity of knowledge⁶⁵. There is no gold standard for the diagnosis of this impairment but discussing the patient's condition and asking the right questions can lead to a successful diagnosis.

Healthcare providers' awareness, perceptions, and knowledge of these side effects and their cause must be conveyed through transparent communication and discussion. Such information sharing and patient awareness will lead to better management of symptoms when the side effects appear⁶⁶.

This study's strength is its uniqueness. Healthcare providers' knowledge, attitudes, and perceptions predicted their intentions to share information about chemotherapy-induced memory impairment. This study addresses the literature gap in healthcare providers' perceptions, awareness, and knowledge of this issue. It identified the implications of healthcare providers' subjective norms for sharing information about memory impairment through the lens of a therapeutic agent. It is significant patients informed decision-making to be consistent with ethical and legal guidelines for treatment. Transparent communication between patients and physicians cultivates a healthy relationship, helping patients to overcome depression, fear, and sadness. Furthermore, the patient will be able to anticipate future symptoms or procedures that could hinder progress. Some studies^{67,68} reported that both informed consent and shared information about chemotherapy-induced memory loss contributed to patients' quick recovery.

This study has limitations. Time constraints might have affected respondents' biases, and sampling bias may have affected the accuracy of their responses to the questions. Convenient sampling and use of the online self-administered questionnaire might have inadvertently excluded providers who would otherwise have been willing to participate but were not reached. Our response rate was a significant limitation for a survey-based study. The results of the study cannot be applied to other populations. Last, it might have been preferable to conduct this study as a paper-and-pencil test.

This study leaves room for future studies that engage participants physically and record their responses conveniently. Future recommendations include a large sample size, identifying respondents' biases, and extending the investigation to include other relevant side effects. Future studies should investigate the patient-physicians relationship and the efficacy of treatment. Engaging respondents with diverse opinions using face-to-face contact while they list their views may improve the response rate.

Conclusions

Healthcare providers' attitudes, subjective norms, and behaviors are related to their intention to inform cancer patients about chemotherapeutic agent-induced memory impairment. Participants' awareness and perceptions are associated with their knowledge of chemotherapy-induced memory impairment. Providers' lack of awareness, perceptions, and knowledge emphasize the need for a collaborative learning system to enhance our understanding of this phenomenon and ease post-treatment challenges faced by cancer survivors. Future studies, such as qualitative analysis of physician responses, are recommended. This research provides a dimension to explore healthcare providers' intentions to share information with patients as an intervention by a therapeutic agent, and the role of effective communication in the healthcare provider-patient relationship to improve the quality of care.

Conflict of Interest

The Authors declare that they have no conflict of interests.

Ethical Approval

The study was approved by the Subcommittee of Health Research Ethics at the Deanship of Scientific Research at Qassim University (No. 2158043).

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