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Prevalence and Correlates of Chemotherapy-Induced Cognitive Impairment in Cancer Patients at Mahavir Cancer Sansthan, Patna: A Cross-Sectional Study

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ABSTRACT

Cancer-related cognitive impairment (CRCI) significantly impacts the quality of life of cancer survivors, yet awareness of its effects remains limited. This cross-sectional study at Mahavir Cancer Sansthan, Patna, assessed the proportion of cognitive impairment among 140 chemotherapy-treated cancer patients using the Montreal Cognitive Assessment (MoCA). Findings revealed that 78.5% (110 patients) exhibited cognitive deficits, particularly in attention and memory, while only 30 showed no impairment. The study highlights the high prevalence of CRCI, emphasizing the need for early detection and supportive care in oncology practice. Although no significant correlations were found between cognitive impairment and variables like age, gender, or cancer stage, the results align with existing evidence of chemotherapy-induced cognitive dysfunction. The study underscores the necessity for further research to identify predictors of CRCI and develop targeted interventions. Oncology nurses play a crucial role in educating patients and managing cognitive side effects, ensuring better survivorship care. This study serves as a foundational step in addressing CRCI in Bihar's cancer population, advocating for integrated cognitive assessments in treatment protocols to improve patient outcomes..

Keywords: *Cognitive Impairment, Cancer, Chemotherapy, MoCA.*

1. INTRODUCTION

Cancer patients face a significantly higher risk of mental health issues compared to the general population [1–5]. The COVID-19 pandemic further exacerbated these challenges, with many patients unable to resume cancer treatment due to pandemic-related disruptions [6]. Advances in oncology have improved survival rates, even for metastatic cancers, leading to a growing population of long-term survivors. However, cancer treatments often come with long-term or latent side effects that impact quality of life, morbidity, and overall survival [3]. Chemotherapy, for instance, can cause a range of adverse effects, including cognitive impairments, alopecia, headaches, and damage to vital systems such as cardiac, respiratory, and gastrointestinal functions [10]. Among these, chemotherapy-related cognitive impairment (CRCI), often referred to as "chemo brain" or "chemo fog," is one of the most debilitating conditions, affecting patients' daily functioning and overall well-being [8].

Mild cognitive impairment (MCI) has emerged as a major public health concern due to its association with an increased risk of dementia [5]. Cognitive disabilities can range from mild to severe, affecting memory, learning, attention, and decision-making [12]. In cancer patients, CRCI is characterized by declines in neuropsychological functions, even in those without central nervous system tumors, and can result from chemotherapy, radiation therapy, or surgery [13]. Studies indicate that up to 30% of patients exhibit cognitive deficits before chemotherapy, 75% report impairments during treatment, and 35% continue to experience symptoms years after treatment completion [11,14]. These deficits often manifest as difficulties in spatial processing, attention, impulse control, concentration, and memory, leading to increased anxiety and reduced work performance [8].

Several factors contribute to CRCI, including chemotherapy, hormone therapy, and surgical anesthesia [8]. Genetic predispositions, such as polymorphisms in apolipoprotein E (APOE), catechol-O-methyl transferase (COMT), and brain-derived neurotrophic factor (BDNF) genes, also play a role [8,9]. The most commonly affected cognitive domains include memory, processing speed, concentration, and executive functions [9]. Patients frequently report difficulties in performing routine tasks such as meal planning, managing finances, and organizing daily activities, significantly impacting their independence [10].

Neuropsychological testing remains the gold standard for diagnosing MCI [11]. However, awareness and early detection of CRCI are crucial for effective management. Oncology nurses play a pivotal role in educating patients, monitoring cognitive changes, and implementing supportive care strategies [12]. Despite existing research, gaps remain in understanding the prevalence and mechanisms of chemotherapy-induced cognitive impairment (CICI), particularly in non-chemotherapy treatments like hormone therapy and post-operative radiation therapy (RT).

This study aims to assess the prevalence of cognitive impairment among cancer patients at Mahavir Cancer Sansthan and Research Institute, Patna, Bihar, and explore the impact of age, gender, chemotherapy regimen, and cancer stage on cognitive dysfunction. To our knowledge, no prior studies have systematically evaluated CRCI in Bihar's cancer population. The findings will contribute to developing targeted oncology care strategies, improving patient outcomes, and enhancing quality of life. Additionally, this research seeks to raise awareness among oncology nurses, promoting better cognitive health monitoring and intervention in cancer survivors.

2. METHODS:

This cross-sectional study was conducted among cancer patients undergoing chemotherapy at Mahavir Cancer Sansthan & Research Centre (MCSRC), Patna, using a convenience sampling approach. The study aimed to assess the prevalence of cognitive impairment and examine factors influencing cognitive function in these patients. Based on previous research indicating a 30% baseline rate of cognitive impairment in pre-chemotherapy cancer patients [14], a sample size of 140 participants was calculated to achieve 95% confidence with a 5% margin of error. The study included all eligible cancer patients visiting MCSRC, regardless of age, gender, or cancer stage. Potential participants were screened according to the study criteria, and those who qualified were enrolled after providing informed consent. Cognitive function was evaluated using the Montreal Cognitive Assessment (MoCA) scale, selected for its high sensitivity and specificity in detecting cognitive impairment. This standardized tool allowed for reliable assessment of cognitive deficits in the study population.

3. MEASURES

Sociodemographic and clinical characterstics

Data Collection and Cognitive Assessment

Eligible patients who met the study criteria were approached individually for data collection. Researchers administered a structured demographic questionnaire to collect comprehensive information, including:

Age, height, and weight

Blood pressure measurements

Past medical history

History of substance use

Family medical history

4. COGNITIVE FUNCTION EVALUATION

Cognitive impairment was assessed using the **Montreal Cognitive Assessment (MoCA)**, a validated screening tool selected for its high sensitivity (90%) and specificity (87%) in detecting mild cognitive dysfunction [11]. The evaluation was conducted through:

- Face-to-face interviews
- Standardized MoCA questionnaire administration
- Systematic scoring of cognitive domains (memory, attention, language, etc.)

This rigorous methodology ensured reliable detection of chemotherapy-related cognitive impairment while accounting for potential confounding factors through comprehensive demographic data collection.

The Montreal Cognitive Assessment (MoCA) is a comprehensive screening tool that evaluates multiple cognitive domains through specific tasks: alternating trail making (0-1 point), visuo constructional skills using a cylinder drawing (0-1), naming (0-3), memory (0-3), attention (0-2), vigilance (0-1), serial 7s subtraction (0-3), sentence repetition (0-2), verbal fluency (0-1), abstraction (0-2), delayed recall (0-5), and orientation (0-6). Participants with 12 or more years of formal education received an additional 1 point. This 10-minute assessment measures visuospatial abilities, attention, language, problem-solving, delayed recall, working memory, and orientation, demonstrating superior sensitivity and specificity compared to the MMSE by covering broader cognitive domains. The MoCA, available in multiple languages with printable versions and training resources on its official website, uses a 30-point scale, with scores ≥26 considered normal. For data collection, potential participants visiting Mahavir Cancer Sansthan & Research Centre (MCSRC) were screened against study criteria, and eligible patients provided informed consent after being thoroughly briefed about the study's purpose, procedures, and their right to withdraw anytime. Participants understood that their medical records, prescriptions, and test results would be reviewed to improve cancer treatment outcomes and quality of life. Statistical analysis involved descriptive statistics to summarize sociodemographic and clinical characteristics, while multiple linear regression in SPSS identified predictors of cognitive dysfunction, with MoCA domain scores as dependent variables and age, education, and chemotherapy cycles as independent variables, using a significance threshold of $p<0.05$. This rigorous methodology ensured reliable assessment of chemotherapy-related cognitive impairment while maintaining ethical research standards.

Table 1. Sociodemographic and Clinical Characteristics of Study Participants

Sociodemographic and Clinical Characteristics (N=140)

Variable	Category	N (%) / Mean ± SD
Age (years)	Mean ± SD	49.53 ± 12.6
	Range	19–76
Education	Primary	46 (32.7%)
	High School	17 (12.4%)
	College	15 (10.7%)
	Intermediate	28 (20%)
	Uneducated	34 (24.2%)
Gender	Male	49 (35%)
	Female	91 (65%)
Marital Status	Married	134 (95.7%)
	Single	6 (4.3%)
Cancer Type	Breast Cancer	45 (32.3%)
	Gallbladder Cancer	32 (22.8%)
	Oral Cancer	12 (8.5%)
	Lung Cancer	6 (4.3%)
	Skin Cancer	2 (1.4%)
	Pancreas Cancer	2 (1.4%)
	Cervical Cancer	11 (7.9%)
	Ovarian Cancer	4 (2.8%)
	Prostate Cancer	2 (1.4%)
	Rectum Cancer	3 (2.2%)
	Others*	21 (15%)
Cancer Stage	Stage 1	81 (57.9%)
	Stage 2	25 (17.9%)

	Stage 3	**34 (24.2%)**
Chemotherapy Cycle	**1**	**27 (19.3%)**
	2	**26 (18.6%)**
	3	**40 (28.5%)**
	4	**28 (20%)**
	5	**12 (8.6%)**
	6	**7 (5%)**

5. RESULTS:

Sociodemographic and Clinical Characteristics of Study Participants:

Among 140 participants, the majority were female (65%), with a mean age of 49.53 years (SD = 12.6; range: 19–76). Education levels varied: 32.7% had primary education, 12.4% completed high school, 20% intermediate, 10.7% held a college degree, and 24.2% had no formal education.

Cancer Stage Distribution:

- Stage I: 57.9%
- Stage II: 17.9%
- Stage III: 24.2%

Chemotherapy Cycles: Average of 6 cycles (range: 1–6).

Cancer Type Prevalence:

Breast cancer (32.3%) was most common, followed by gallbladder cancer (22.8%), oral cancer (8.5%), cervical cancer (7.9%), and others (28.5%).

Cognitive Impairment by Chemotherapy Regimen:

Cyclophosphamide alone: 10 of 11 patients (90.9%) had mild-to-moderate impairment.

Cisplatin + Gemcitabine: 35 of 36 patients (97.2%) impaired.

Paclitaxel: 13 of 14 patients (92.9%) impaired.

Adriamycin + Cyclophosphamide: 25 of 29 patients (86.2%) impaired.

Other drugs (e.g., Bevacizumab, Oxaliplatin) were less frequently used, with no impairment data provided.

Table: 2 Cognitive Impairment by Chemotherapy Regimen

Chemotherapy Regimen	Total Patients	Patients with Cognitive Impairment	Impairment Rate
Cyclophosphamide alone	**11**	**10**	**90.9%**
Cisplatin + Gemcitabine	**36**	**35**	**97.2%**
Paclitaxel	**14**	**13**	**92.9%**
Adriamycin + Cyclophosphamide	**29**	**25**	**86.2%**
Other regimens*	**50**	**Data not reported**	**—**

***Other regimens included Bevacizumab, Oxaliplatin, Capecitabine, Methotrexate, etc.**

Descriptive Statistics for Cognitive Function Assessment (N=140): The effects of chemotherapy on the eight domains of the MoCA scores are shown in Table 3 The average MoCA score was 22.9 (SD=3.26), ranging from 14 to 27. It should be

emphasised that 43.6 percent of subjects had moderate to severe cognitive impairment, whereas 31.4 percent had mild cognitive impairment. Among the study participants, the score was lower for cognitive domains of divergent attention and short term memory.

Table 3. Descriptive Statistics for Cognitive Function Assessment (N=140)

Variable	N	%	Mean	SD	Range
MoCA	-	-	22.9	3.269	0-30
≤23	61	43.6%	-	-	-
24-26	44	31.4%	-	-	-
≥27	35	25%	-	-	-
Visuospatial	-	-	3.52	1.52	0-5
Naming	-	-	2.71	0.49	0-3
Attention	-	-	3.44	1.34	0-6
Language	-	-	1.73	1.01	0-3
Abstraction	-	-	1.78	0.50	0-2
Memory	-	-	2.36	1.64	0-5
Orientation	-	-	5.53	0.86	0-6

Note: MoCA is Montreal Cognitive Assessment

Regression Analysis: In assessing the possible predictors of cognitive dysfunction, SPSS software was used to run a multiple linear regression analysis. Age, education and chemotherapy cycles were regarded as independent variables, while the MoCA (cognitive domains) was treated as a dependent variable. For all analyses, the threshold of significance was set at 0.05. Table 4 shows the predictors of cognitive impairment based on multiple regression analyses. Because the p value was greater than 0.05, age (β = 0.04), level of education (β =-0.51), education (β =0.21), and cycle (β = -0.016) were not significant predictors of cognitive impairment among cancer patients in the regression model. There was no significant relationship between variables.

Table 4. Cognitive Dysfunction Predictors in Study Participants

Variable	β	SE	t	P
Cycle	-0.0164	0.20513	-0.07994	0.936399
Education	0.217714	0.221002	0.985122	0.326326
Gender	-0.5161	0.59064	-0.8738	0.383777
Age(yrs.)	0.040919	0.022499	1.818712	0.071172
NOTE: R Square 0.0350418, Adjusted R Square 0.006450477, F=1.22Significance F=0.30				

6. DISCUSSION

While many chemotherapy regimens are known to cause neurotoxicity, their effects on cognitive function remain understudied. This cross-sectional study aimed to assess the prevalence of cognitive impairment in cancer patients and identify influencing factors. Our findings support existing evidence that standard-dose adjuvant chemotherapy adversely affects cognition, with 78.5% of patients exhibiting moderate-to-severe cognitive impairment. This aligns with prior studies reporting elevated rates of cognitive decline in chemotherapy-treated Regional Disparities and Subtype Prevalence

The observed impairment rate in our study exceeds earlier estimates from other regions of India (e.g., 19.26% in North India

and 14.9% in East India using the Kolkata Cognitive Screening. This discrepancy likely stems from differences in study populations and diagnostic criteria. Notably, multiple-domain amnesic mild cognitive impairment (MCI) emerged as the most prevalent subtype, underscoring the need for targeted early detection strategies.Subgroup analyses revealed that drugs such as 5-fluorouracil (5-FU), cyclophosphamide, and cisplatin are strongly associated with cognitive deficits, particularly in attention and memory domains (Ahles *et al.*, 2001; Janelsins *et al.*, 2012). Key findings include: Adriamycin + Cyclophosphamide: 86.2% impairment rate (25/29 patients).Cisplatin + Gemcitabine: 97.2% impairment rate (35/36 patients).Cyclophosphamide alone: 90.9% impairment rate (10/11 patients).Physiological studies suggest chemotherapy-induced white matter alterations as a potential mechanism for these deficits. However, our study found no significant multivariate correlations between demographic variables and cognitive outcomes, consistent with earlier work .

7. CONCLUSION

The incidence of cognitive impairment among cancer patients in this study was notably high, with the majority of chemotherapy recipients exhibiting moderate-to-severe deficits, particularly in attention and memory domains. These impairments can significantly disrupt daily functioning, occupational performance, and overall quality of life, underscoring the clinical urgency of addressing chemotherapy-related cognitive dysfunction (CRCI). The findings align with prior research demonstrating the neurotoxic effects of regimens such as Adriamycin-Cyclophosphamide and Cisplatin-Gemcitabine, which were associated with impairment rates exceeding 85% in this cohort. While no significant correlations between sociodemographic variables and cognitive outcomes were identified—consistent with some existing literature—the study's limitations, including its modest convenience sample (N=140) and restriction to a single region (Patna, Bihar), caution against broad generalization. Nevertheless, the results highlight a critical need for systematic cognitive screening and tailored interventions in oncology practice. To mitigate CRCI's burden, a multidisciplinary framework—integrating oncology pharmacists, nurses, and rehabilitation specialists—must prioritize patient education, routine monitoring, and evidence-based cognitive rehabilitation. Future studies should expand geographically, incorporate longitudinal designs, and explore neuroprotective strategies to optimize care for India's growing population of cancer survivors.

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