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REVIEW ARTICLE

Chemobrain: A Review on Cognitive Impairment Induced by Chemotherapy

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ABSTRACT

Chemotherapy has markedly improved cancer survival outcomes, yet its unintended impact on cognitive function commonly referred to as chemobrain has emerged as a significant survivorship concern. Chemobrain is characterised by deficits in memory, attention, executive functions, and processing speed, affecting up to 75% of patients during treatment and persisting in approximately one-third of survivors. Its pathophysiology involves multiple mechanisms, including direct neurotoxicity, neuroinflammation, oxidative stress, hormonal dysregulation, and disruption of the blood brain barrier. Clinical manifestations such as mental fogginess, memory lapses, and reduced multitasking ability substantially impair daily functioning, emotional well-being, and work productivity. Diagnosis requires a multidimensional approach incorporating patient history, neuropsychological testing, neuroimaging, and biomarker evaluation. Management strategies include pharmacological interventions, lifestyle modifications, cognitive rehabilitation, and comprehensive nursing care. Nurses play a pivotal role in early detection, patient education, interdisciplinary coordination, and ongoing psychosocial support. Understanding the mechanisms, risk factors, and evidence-based interventions for chemobrain is essential for optimising survivorship care and enhancing the quality of life for cancer patients.

KEYWORDS

• Chemobrain • Chemotherapy • Survivorship

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INTRODUCTION

Chemotherapy has significantly improved cancer survival rates, but its adverse effects on cognitive function have raised concerns. Chemo brain is characterised by cognitive decline, affecting verbal memory, executive function, and processing speed.[1] Chemotherapy-related cognitive impairment experienced by cancer patients during or after chemotherapy treatment.[2] Understanding its mechanisms and prevention strategies is crucial for improving the quality of life of cancer survivors. Chemo brain, also referred to as chemotherapy-induced cognitive dysfunction. While traditionally considered a temporary side effect, emerging research suggests that chemo brain can persist long after treatment, affecting the quality of life of cancer survivors.

Chemotherapy targets rapidly dividing cancer cells, but its systemic nature means it can also affect healthy cells, including neurons. Patients undergoing chemotherapy frequently report cognitive challenges such as forgetfulness, difficulty concentrating, and mental fog. Initially dismissed as stress-related or a secondary effect of cancer itself, chemo brain is now recognised as a distinct neurocognitive impairment.

Its prevalence varies across studies, with estimates suggesting that up to 75% of cancer patients experience cognitive impairment during treatment, and around 35% continue to experience symptoms long after treatment completion.[2]

The growing recognition of chemobrain as a significant post-treatment complication has prompted extensive investigations into its underlying mechanisms, including neurotoxicity, inflammation, oxidative stress, and hormonal imbalances. The impact of these changes extends beyond neurological function, influencing emotional well-being, work productivity, and social interactions, making chemobrain a substantial concern in survivorship care.

Pathophysiology of Chemobrain

Chemotherapy-induced cognitive impairment is believed to result from several interrelated mechanisms:

1. **Direct Neurotoxicity:** Cytotoxic drugs such as methotrexate, doxorubicin, and cisplatin have been shown to damage neural structures, leading to apoptosis and reduced neurogenesis.[3,4,5]
2. **Inflammatory Response:** Increased levels of pro-inflammatory cytokines, including tumour necrosis factor-alpha (TNF-α) and interleukin-6 (IL-6), contribute to neuroinflammation, disrupting synaptic plasticity and cognitive function.
3. **Oxidative Stress:** Chemotherapy induces excessive oxidative stress, leading to mitochondrial dysfunction and neuronal damage. Free radicals generated during treatment interfere with normal neuronal signalling, exacerbating cognitive decline.[6]
4. **Blood-Brain Barrier (BBB) Disruption:** Chemotherapeutic agents compromise the integrity of the BBB, permitting the influx of toxic metabolites into the central nervous system (CNS) and further exacerbating neurodegeneration.[7]
5. **Hormonal Dysregulation:** Hormone-targeting therapies, particularly those used for breast and prostate cancers, can contribute to cognitive impairment by altering estrogen and testosterone levels, which play critical roles in neuroprotection and cognitive processing.[8]

Risk Factors

Factors that may increase the risk of chemo brain and memory changes in people with cancer include:

- Brain cancer.
- Cancer that spreads to the brain.
- Higher doses of chemotherapy or radiation.
- Radiation therapy to the brain.
- Younger age at time of cancer diagnosis and treatment.
- Older age.
- Pre-existing cognitive conditions.
- Psychological stress and fatigue.

Clinical Manifestation and Patient Experience

Patients experiencing chemobrain report symptoms such as:

- Difficulty in finding words and remembering names.
- Short-term memory lapses, affecting day-to-day tasks.

- Impaired multitasking and reduced mental agility.
- Feeling "mentally foggy" and slow in cognitive processing.

These impairments can significantly impact a patient's ability to work, socialise, and maintain independence, underscoring the necessity for early intervention and comprehensive management strategies.

Diagnosis

The diagnosis of chemobrain requires a multi-faceted approach that combines objective cognitive assessment, neuroimaging studies, and laboratory evaluations. These methods are crucial in differentiating cognitive impairment induced by chemotherapy from other neurological or psychological conditions.

Clinical Assessment

Patient History: The patient's cognitive symptoms include onset, duration, and severity, affecting daily activities and work-life, with co-existing conditions such as depression, anxiety, and sleep disturbances.

Neuropsychological Testing

1. **Standardised Cognitive Assessments:** Patients suspected of experiencing chemobrain typically undergo comprehensive neuropsychological evaluations. These tests assess domains such as memory, attention, executive function, and processing speed. Widely used instruments include:

   A **Montreal Cognitive Assessment (MoCA):** Designed to screen for mild cognitive impairment, it evaluates diverse cognitive skills such as visuospatial ability and memory.

   B. **Mini-Mental State Examination (MMSE):** Often used as an initial screening tool, particularly in detecting global cognitive changes.

   C. **Domain-Specific Tests:** Tests like the Trail Making Test, Digit Span, and verbal learning tasks help pinpoint deficits in executive function and memory.

   These assessments not only provide an objective measure of cognitive performance but also serve as a baseline for monitoring changes over time during and after chemotherapy.

2. Neuroimaging Techniques

A. **Magnetic Resonance Imaging (MRI) and Functional MRI (fMRI):** MRI scans help detect subtle structural changes in the brain, such as reduced grey matter volume in regions linked to memory and executive function. Functional MRI (fMRI) offers insights into altered neural connectivity and metabolic activity, which may correlate with cognitive deficits experienced by patients.

B. **Positron Emission Tomography (PET):** PET scans measure brain metabolism and can reveal areas of hypometabolism that often accompany cognitive impairment. These imaging modalities contribute significantly to understanding the neurobiological impact of chemotherapeutic agents on the brain.

3. Biomarker Evaluation:

A **Inflammatory and Oxidative Stress Markers:** Research has shown that chemotherapy can elevate peripheral levels of inflammatory cytokines (e.g., interleukin-6 [IL-6] and tumour necrosis factor-alpha [TNF-α]) and markers of oxidative stress. These biomarkers are being explored as potential indicators of treatment-induced neuronal damage and inflammation. Moreover, emerging marker's such as neurofilament light chain are under investigation for their sensitivity in identifying early neuronal injury related to chemobrain.

B **Cerebrospinal Fluid (CSF) Analysis:** Changes in tau proteins and amyloid-beta levels, similar to neurodegenerative disorders.

Management of Chemobrain

Chemobrain, or chemotherapy-induced cognitive impairment, requires a multidimensional management approach involving medical interventions and nursing care. Both strategies aim to reduce cognitive deficits, improve patient quality of life, and enhance overall well-being.

Medical Management

1. Pharmacological Interventions

Several medications have been explored to alleviate the cognitive effects of chemobrain:

Neuroprotective Agents: Antioxidants such as Vitamin E and Omega-3 fatty acids may help combat oxidative stress-induced neuronal damage. Anti-inflammatory drugs like Ibuprofen or Celecoxib have been studied for their potential in reducing neuroinflammation linked to chemobrain.

Cognitive Enhancers: Medications such as Modafinil (a stimulant) can improve attention and memory. Acetylcholinesterase inhibitors such as Donepezil may help enhance cognitive processing.

Hormonal Therapy Adjustments: Patients receiving hormone therapy for breast or prostate cancer may require modifications, as estrogen and testosterone fluctuations can contribute to cognitive decline.

2. Behavioural and Lifestyle Modifications

- **Physical Activity:** Regular exercise improves circulation, reduces inflammation, and promotes neurogenesis.
- **Cognitive Rehabilitation:** Engaging in mental exercises such as puzzles, reading, and structured cognitive therapy can enhance cognitive function.
- **Dietary Adjustments:** Foods rich in antioxidants (berries, leafy greens), polyphenols (green tea, dark chocolate), and Omega-3 fatty acids (fish, walnuts) support brain health.
- **Stress Management:** Mindfulness meditation, yoga, and relaxation techniques help mitigate cognitive impairments linked to stress.

Nursing Management

- Patient Assessment and Monitoring:
  1. Montreal Cognitive Assessment (MoCA)
  2. Mini-Mental State Examination (MMSE)
  3. Trail Making Test (TMT)
  4. Regular documentation of cognitive symptoms helps in adjusting treatment strategies.
- **Patient Education and Counselling:** Educate patients and caregivers about chemobrain, helping them understand symptoms, triggers, and strategies for coping. Providing counselling sessions to address frustration, anxiety, and emotional distress associated with cognitive impairment.
- **Implementing Cognitive Rehabilitation Strategies:** Encouraging patients to engage in mental exercises (crossword puzzles, memory games). Teaching organisation techniques such as maintaining daily planners and reminder apps to assist memory.
- **Coordination of Multidisciplinary Care:** Liaise between neurologists, oncologists, psychologists, and rehabilitation specialists to ensure a comprehensive approach to management. Assisting patients with therapy referrals, such as speech therapy for verbal memory issues or physical therapy for improved motor function.
- **Emotional and Psychosocial Support:** Providing reassurance and motivation to patients experiencing chemobrain-related distress. Leading support groups where patients share experiences and coping strategies.

The Role and Responsibility of Nurses in Managing Chemobrain

Nurses are at the frontline of patient care and play a pivotal role in detecting, managing, and advocating for patients suffering from chemobrain. Their responsibilities extend from early assessment to ongoing management and coordination of interdisciplinary care.

Assessment and Monitoring

Initial Screening: Nurses are often the first to notice subtle cognitive changes in patients receiving chemotherapy. By administering simple cognitive screening tools and compiling comprehensive patient histories, nurses can help identify early signs of cognitive decline.

Continuous Monitoring: Regular follow-up assessments and the documentation of cognitive changes are critical. This monitoring aids in identifying trends over time and supports the involvement of neuropsychologists or oncologists when further evaluation is needed.

Patient Education and Counselling

Educating About Chemobrain: Nurses play an essential role in informing patients and their families about the possibility of cognitive side effects associated with chemotherapy. A clear explanation of what chemobrain is, how it might present, and the mechanisms involved can help set realistic expectations about treatment outcomes.

Counselling Strategies: Beyond informational support, nurses provide emotional support by reassuring patients and guiding them through coping strategies. They suggest lifestyle modifications such as regular physical exercise, cognitive training exercises, and stress-reduction techniques that may help mitigate cognitive decline.

Coordination of Interdisciplinary Care

Facilitating Referrals and Consultations: Nurses serve as liaisons among oncologists, neuropsychologists, rehabilitation specialists, and primary care providers. This interdisciplinary coordination ensures that patients receive comprehensive care, from advanced neuroimaging assessments to tailored cognitive rehabilitation programs.

Advocacy: Nurses advocate for patients' cognitive health by ensuring that symptoms of chemobrain are taken seriously in clinical settings. This advocacy can lead to earlier interventions and adjustments in treatment plans that accommodate the patient's cognitive well-being.

Supportive Care and Research Involvement

Emotional and Psychological Support: Recognising the emotional toll associated with cognitive impairment, nurses provide empathetic care and facilitate referrals to mental health services when necessary. This supportive role is crucial in maintaining the overall quality of life and mental health of patients.

Data Collection and Research: In many healthcare settings, nurses are actively involved in clinical research and quality improvement initiatives. Their detailed observations and careful documentation contribute to the growing body of knowledge on chemobrain, ultimately helping to refine diagnostic criteria and management protocols.

CONCLUSION

Chemobrain is a significant concern for cancer patients undergoing chemotherapy. Chemobrain represents a significant and often under-recognised consequence of chemotherapy, with the potential to affect cognitive function long after cancer treatment has ended. Its multifactorial pathophysiology including neurotoxicity, inflammation, oxidative stress, hormonal changes, and blood–brain barrier disruption highlights the complexity of this condition and the need for comprehensive assessment and intervention. Early diagnosis through cognitive screening, neuroimaging, and biomarker evaluation is essential for distinguishing chemobrain from other cognitive disorders. Effective management requires an integrated approach combining pharmacological therapies, lifestyle modifications, cognitive rehabilitation, and robust nursing support. Nurses play a central role in monitoring cognitive changes, educating patients and families, coordinating multidisciplinary care, and providing emotional and psychosocial support. Continued research is vital to improving diagnostic accuracy, refining treatment strategies, and ultimately reducing the burden of chemobrain, thereby enhancing the overall quality of life for cancer survivors.

REFERENCES

1. Chemobrain: Insight the possible mechanisms of action induced by chemotherapeutic agents. Hassan MM, Wahdan SA, El-Naga RN, Abdelghany TM, El-Demerdash E. 1, 2024, Archives of Pharmaceutical Sciences Ain Shams University, Vol. 8, pp. 59-75.
2. Prevalence, mechanisms, and management of cancer-related cognitive impairment. Janelsins MC, Kesler SR, Ahles TA, Morrow GR. 1, 2014, Int Rev Psychiatry., Vol. 26, pp. 102-113.
3. Chemotherapy and cognition: comprehensive review on doxorubicin-induced chemobrain. El-Agamy, S., Abdel-Aziz, A., Esmat, A. *et al.* 2019, Cancer Chemother Pharmacol, Vol. 84, pp. 1–14.
4. Mechanisms of Chemotherapy-Induced Neurotoxicity. Was H, Borkowska A, Bagues A, Tu L, Liu JYH, Lu Z, Rudd JA, Nurgali K, Abalo R. 28 March 2022, Front Pharmacol., Vol. 13.

5. Cognitive dysfunction in chemobrain: Molecular mechanisms and therapeutic implications. Hyung-Goo Kim, Mohammad Abdur Rashid, Michael Poleschuk et al. 2025, Biomedicine & Pharmacotherapy, Vol. 192.

6. —.Hyung-Goo Kim, Mohammad Abdur Rashid, Michael Poleschuk, Faheem Ullah, Sang Hoon Lee, Sang Hoon Kim, Bo Qin, X.F. Steven Zheng, Mi-Hyeon Jang. 2025, Biomedicine & Pharmacotherapy, Vol. 192.

7. Ongnok, B., Thiankhaw, K., Chattipakorn, N., Chattipakorn, S.C. Chemobrain in Cancer Treatment: Mechanisms and Its Prevention. [book auth.] N. Rezaei. Handbook of Cancer and Immunology. 2022.

8. Cognitive impairment following hormone therapy: current opinion of research in breast and prostate cancer patients. Wu LM, Amidi A. 1, March 2017, Curr Opin Support Palliat Care., Vol. 11, pp. 38-45.